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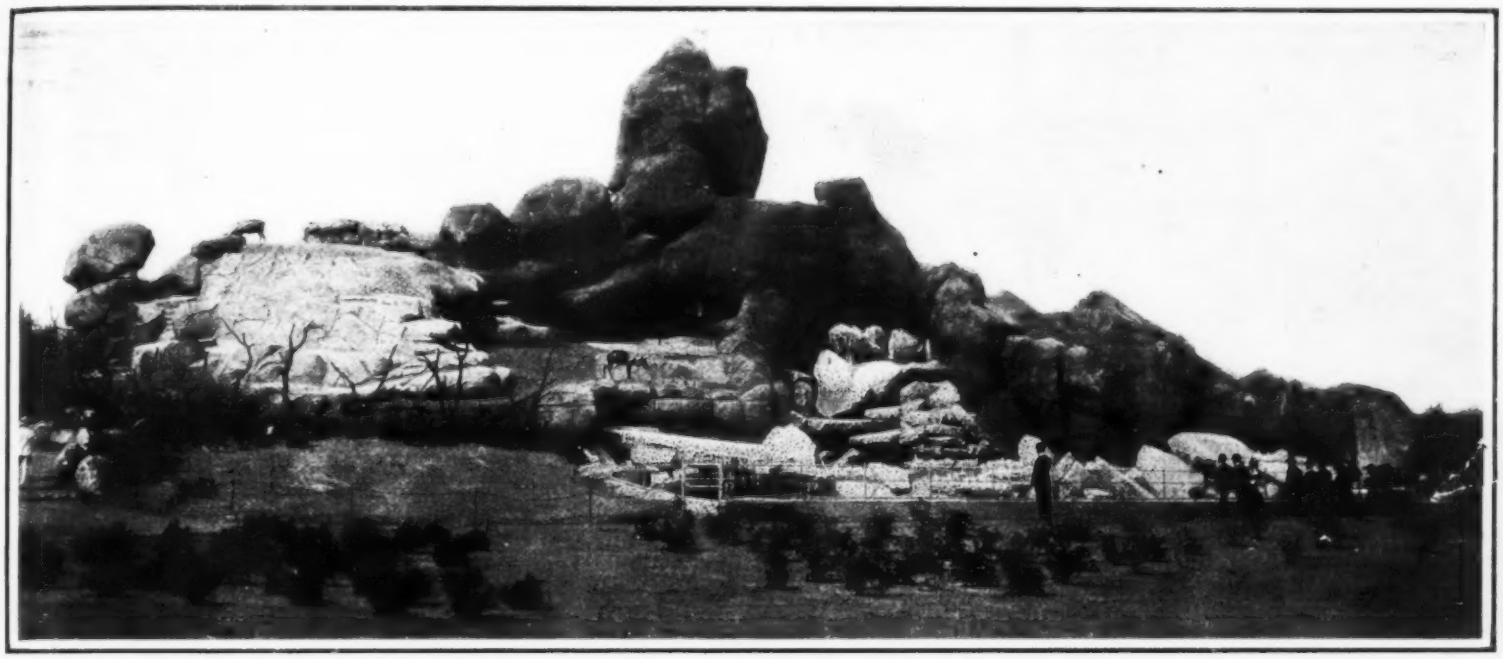


TO THE LEFT ARE REINDEERS AND TO THE RIGHT POLAR BEARS, SEALS, SEA-LIONS, AND OTHER ARCTIC ANIMALS.

THE ENTRANCE GATES. THE FIGURES OF MEN AND ANIMALS ARE EXECUTED IN BRONZE.

THE COMPLETION OF CARL HAGENBECK'S NOVEL ZOOLOGICAL PARK.—[See page 88.]

THE GYROSCOPE.*

AN EXPLANATION WITHOUT MATHEMATICS.

BY C. M. BROOMALL.

IT has always seemed to the writer that an explanation of the action of the gyroscope in everyday language and free from mathematics was something to be desired. It is with the idea of offering such an explanation that what follows is written. No claim for it can be made other than that it is a straightforward, practical treatment of a difficult subject.

All gyroscopic phenomena take place as the result of the operation of a certain dominating influence known as the gyroscopic force. No matter how complicated and apparently unexplainable the action may be, it is to this force, modified more or less by the attending circumstances, that all the phenomena exhibited by the gyroscope, top, or other instrument, are due. An understanding of the nature and cause of the gyroscopic force is therefore the first essential to an understanding of the matter in question.

In Fig. 1, let *AB* represent a circular plane perpendicular to the plane of the paper rotating, for instance, in a direction so that *A* approaches and *B* recedes from the reader. Let *ab* be the axis of rotation of the wheel. Suppose now the axis constrained to move in the plane of the paper in the direction shown by the arrow. Let *AB*, *A'B'*, *A"B"*, and *ab*, *a'b'*, *a"b"* be successive positions of the wheel and axis at successive instants of time. Assume for consideration any convenient number, say sixteen, symmetrically situated points around the wheel. It goes without saying that what applies to these sixteen points will apply to any and all such symmetrical systems of points.

Suppose now that while the wheel is rotating as before assumed the axis moves in the plane of the paper from *ab* through *a'b'* to *a"b"*. The wheel will then pass from *AB* through *A'B'* to *A"B"* as shown. While this is occurring each of our sixteen particles is forced to move through a certain curved path as a result of the combination of the two rotations. The curved lines in the figure are meant to represent the paths of the particles as projected on the plane of the paper. The arcs described in front of the plane of the paper are shown in solid lines and those behind the plane of the paper in dotted lines. The arrows show the direction of the motion. In the figure the angular velocity of the wheel and axis are assumed the same.

As the various particles describe the curves centrifugal forces are of course developed. These centrifugal forces at all times except when the particles are in the plane of the paper have moments around the line of intersection of the plane of the wheel with the plane of the paper. A glance shows that the particles above the plane of the paper and likewise those behind the plane of the paper conjoin to make the end *a* of the axis recede and the end *b* advance.

Let us examine the matter more in detail. As will be seen each particle in the figure is shown in three successive positions of its curved path. This together with the known velocity of the particle supplies the information necessary to determine the direction and amount of the centrifugal force of the given particle at any moment. The centrifugal force of any particle, say when the wheel is in the position *A' B'*, is a function of the path of the particle in space as the wheel changes from *AB* to *A"B"*. Considering the position *A'B'* therefore we see that there is a perfect symmetry of motion of all the particles in front of and behind the plane of the paper by which all components of centrifugal force except those tending to move the axis perpendicular to the plane of the paper are neutralized. In other words, the various particles pair off with one another in such a way that the only unbalanced forces left are those tending to push *a* perpendicularly back from the plane of the paper and to draw *b* forward. This constitutes what is known as the gyroscopic force. It is of the nature of a couple, the middle of whose lever arm is at the center of the wheel. It can of course only be balanced by an equal couple.

The gyroscopic force, as has been shown, always acts at right angles to the plane in which the axis is moving, changing in direction as the plane of motion of the axis changes and neither tending to increase nor decrease the velocity of motion of the axis, but only to deviate it in direction.

The amount of the gyroscopic force is greater the greater the centrifugal force of the particles. Since the centrifugal force of a body varies directly as the square of its velocity and inversely as the radius, obviously the gyroscopic force increases as the velocity of rotation of the wheel increases and also as the motion of the axis is more rapid. Again, for the same amount of material in the revolving plane and the same angular velocity of rotation it follows that the gyroscopic force will be greater the further the mass of the wheel is disposed from the center. Likewise is the gyroscopic force greater as the rotating mass is greater, as, other things being equal, more particles or systems of particles join together to produce this force.

What has been found regarding the gyroscopic force may be summarized as follows:

I. The gyroscopic force always acts at right angles to the plane of motion of the axis, neither accelerating nor retarding it and only tending to change its direction. The gyroscopic force is of the nature of a couple, and can only be balanced by an equal couple.

II. The gyroscopic force is greater, other things being equal, as the velocity of motion of the axis is greater, as the velocity of rotation of the wheel is greater, as the mass of the wheel is greater and as this mass is more distantly situated as regards the center of the wheel.

Having now traced out the cause and nature of the gyroscopic force, let us see what part this force plays in the action of the gyroscope. In order to investigate the matter properly it is necessary to first treat of the motion of the theoretically perfect instrument and then afterward to ascertain the effect of friction and other causes in modifying this motion.

The theoretical gyroscope we are to consider is one that runs with constant wheel velocity, unaffected by friction of any kind, and whose axis is subjected to an applied couple. It will be assumed supported by the pivot at some point of the axis, the weight of the wheel and the reaction of the pivot constituting the couple, and the apparatus being free to fall if unrestrained. A special case arises when the wheel is mounted in gimbals (which is equivalent to supporting it at the middle of the axis), but in this case a weight must be applied to one end of the axis, which weight, in conjunction with the reaction of the support, supplies the couple.

Consider now the first method of mounting, which is the general case. Suppose the wheel to be in rapid rotation and one end of the axis to be supported on the pivot. Let the instrument be suddenly released. The free end of the axis will, of course, begin to fall. The moment it starts to fall, however, the gyroscopic force or couple begins to act, developing a couple at right angles to the plane of its fall, that is, horizontally. The end of the axis at the pivot being fixed in position the effect of the gyroscopic couple is to act on the free end of the axis so as to deviate it from the vertical fall, carrying with it the whole mass of the wheel. The path of the free end of the axis is now inclined so that the gyroscopic force, always in a plane at right angles to the plane of the motion, is now directed slightly upward as well as horizontally. The fall of the free end of the axis is now still further deviated from the vertical and at the same time its downward fall is somewhat checked by the vertical component of the gyroscopic force or couple. This deviating force continues until finally the axis is moving horizontally and the downward motion has been entirely checked. The gyroscopic force or couple is now directed upward and reacting on the pivot as before begins to deviate the free end of the axis upward. As the path of the axis begins to curve upward the gyroscopic force is directed upward and backward, raising the wheel and at the same time destroying some of its horizontal velocity. The deviating effect of the gyroscopic force continues until the end of the axis just comes to rest with the tangent to its path vertical. The axis is now at the same level as it was when first released, all the velocity gained in its fall having been lost in bringing the mass up to the same level again. The end of the axis now begins to fall again, the gyroscopic couple once more exerts its deviating force and another arc is described. The free end of the axis henceforth describes a series of small cycloidal arcs, the axis coming up to the same level after each arc (Fig. 2). Under ordinary circumstances with high wheel velocity the nutations of the axis are too small to be perceived. The motion of the end of the axis is analogous to that of a vibrating pendulum with its constant interchange of potential and kinetic energy, the gyroscopic force taking the place of the supporting rod or cord in the pendulum. In the operation of the apparatus no exhaustion of energy of rotation of the wheel occurs, since no external work is done and the average orbital velocity is constant. The axis necessarily moves with constant average orbital velocity because the loops of the path are equal and similar, a necessary consequence of being described under similar circumstances.

The two halves of each cycloidal arc are similar and equal, as may be shown by the following reasoning: The velocity of the end of the axis at any point, resulting from the conversion of potential into kinetic energy, is a function only of the distance the axis has fallen. The deviating gyroscopic force being always at right angles to the path of the axis cannot alter the velocity in any way. On the upward arc the loss of velocity at any point is a function of the distance the axis has risen, or in other words, the velocity remaining at any point on the upward arc is a function of the distance it has yet to rise to regain the original level. The total energy of the system being constant and equal to the sum of the potential and kinetic energies, it is evident that for every elevation of the axis there must correspond a given velocity of the axis. Obviously therefore at every level on the two arcs the velocity is the same. Again, the deviating force being a function of the velocity of the axis, it follows that at points on the same level on the two arcs the deviating force is likewise the same. The velocity and deviating force being the two factors which determine the curvature of the path at a given instant, we see that the two arcs are described under such a law that they have always the same radius of curvature at points on the same level. Hence the curves must be similar and equal.

The greater the velocity of rotation of the wheel, the greater is the gyroscopic force and hence the arcs described by the end of the axis are smaller and more frequent. The result is the average orbital velocity is less because the fall now being less, the maximum horizontal velocity at the bottom of each loop is less, and hence the average horizontal velocity is likewise less since the curves are in all cases similar. On the other hand, if the weight of the mountings of the wheel is increased or the weight of the wheel itself increased in such a way as not to compensate for the increase of weight by an increased gyroscopic force, the orbital velocity will be greater. This will result from the fact that it will take the gyroscopic force longer to deviate the fall of the mass into horizontal motion and longer to reconvert the horizontal motion into potential energy at the same level again. The loops will hence be longer, the fall greater and the average resulting orbital velocity greater. The nutations will be more nearly perceptible, if not indeed visible.

The direction of the orbital motion depends of course upon the direction of rotation of the wheel. In order that the apparatus shall not fall, the deviating force must be such as to act upward when the axis is moving horizontally. If in Fig. 1 we assume that we are looking down upon the top of the gyroscope in operation it is obvious that the gyroscopic couple acts in such direction as to make the apparatus self-supporting when the end *a* of the axis rests upon the pivot. We may, therefore, deduce the rule that the free end of the axis always moves in the opposite direction to that in which the top of the wheel moves.

Such is the action of the theoretical gyroscope under ordinary circumstances. Before taking up the phenomena of the practical instrument it is well to consider the effect of certain external influences upon the theoretical instrument.

First: Let us consider the effect produced by an external force tending constantly to accelerate or retard the orbital velocity of the axis. Suppose the force to be accelerative. The result will be that the applied force acting on the apparatus combines with the force of gravitation so that the instrument operates as though the gravitational force were directed downward and slightly ahead. The axis tends to keep the same average "level" with regard to this new force, or in other words to describe an average path at right angles to the force. The axis must therefore rise. The work done upon the axis by the horizontally directed force appears in the potential energy due to the more elevated average position of the wheel. If the applied force is retarding, the circumstances are all reversed and it follows necessarily that the wheel falls. The potential energy due to the fall of the wheel now appears as the work done by the apparatus on the external retarding medium.

Second: Consider the effect of starting the gyroscope with an initial horizontal velocity and then leaving it to itself. The idea at once suggests itself that if this initial velocity is just sufficient to make the gyroscopic couple equal to the gravitational couple it is possible to have an orbital motion free from nutation. This is true, although this condition of things is essentially unstable (except under certain conditions to be mentioned in treating of the practical gyroscope) and upon the least disturbance the ordinary nutating motion will supervene. The nutating motion is essentially stable, on the other hand, and will re-establish itself after any disturbance.

If the instrument is put under way with a velocity less than the above value, the path described will be

* Proceedings of the Delaware County Institute of Science.

that of a prolate cycloid. At the momen of release the axis is moving horizontally, but the gyroscopic force is not sufficient to retain it in a horizontal path. It begins to fall, therefore, and it is only after it has gained velocity by a considerable fall that the gyroscopic force is able to reverse the curvature and bring the axis to horizontal motion. On the up half of the arc a similar curve must be described in reverse order, as will be shown below, and a uniform prolate cycloidal path therefore results (Fig. 3).

It is necessary at this point to digress a moment in order to prove that, no matter what the circumstances of starting, provided the apparatus is left thereafter to itself, the two halves of each loop of the curve are of the same shape and size. A process of reasoning similar to that used in the case of starting from rest may be applied. Suppose the axis has a certain velocity at starting. The deviating gyroscopic force being always at right angles to the direction of motion, obviously cannot alter this initial velocity. The variations of velocity due to the interchange of potential and kinetic energy as the axis rises and falls under the dominance of the deviating force, are superposed upon this initial velocity. As before, then, we have that at each level on either arc there is the same velocity (the initial velocity plus the velocity due to the elevation) and as a consequence the same deviating force. The two halves of the curve, therefore, have equal radii at equal elevations, a symmetrical condition of affairs that necessarily makes both halves of the arc similar and equal.

To resume: We have seen that if the apparatus is started with a velocity less than a critical value, a prolate cycloid will be described, the summits of which are at the original level. If the axis is started with an initial velocity equal to the critical value, a horizontal path results, as has also been shown. If the apparatus is started with an initial velocity greater than the critical value, the axis will at first rise, then reverse curvature and finally move horizontally; it will then fall, gain velocity and reverse its curvature, finally moving horizontally at the bottom of the loop. The other half of the loop will be similar and the curve as before will be a prolate cycloid, but with the summits at a greater elevation. If the initial velocity be made still greater and equal to twice the critical value, it can be shown mathematically that the common cycloidal motion will be again resumed with the bottom of the loops at the level of starting. The motion being cycloidal once more, we know that the initial velocity *must* have been the same as the horizontal velocity generated at the bottom of the loop in the case where the axis starts from rest. Hence the critical value is one-half the horizontal velocity which is attained at the bottom of a loop when the apparatus starts from rest. If an initial velocity still greater than twice the critical value be given to the axis, the curve, as can be shown by analysis, will be a curtate cycloid with the small loops uppermost, the summits being at a higher elevation than ever. If, to pass to the other extreme, the axis is started with an initial velocity directed backward, we will find described another curtate cycloid with the small loops upward, the summits being at the level of starting.

The action of the theoretical gyroscope having been investigated, it now behooves us to ascertain wherein the practical instrument differs in its action from the theoretical. As has been intimated before, the principal modifying factor is friction, tending as it does to slow down the rotation of the wheel and, to oppose the orbital motion.

The results of the modifying influence of friction may be reduced to two classes: (*a*) Those due to the decrease of velocity of rotation of the wheel, and (*b*) Those due to forces opposing the orbital motion.

(a) Perhaps the most important effect of friction is found in its opposing the rotation of the wheel. It is necessary to examine in detail the action of the apparatus as the rotational velocity becomes less and less. As we have already seen, since the deviating force is always at right angles to the direction of motion and cannot influence the velocity of the axis, to every level of the axis there corresponds a certain velocity over and above any initial velocity the axis may have had. This additional velocity results from the interchange of potential and kinetic energy which is constantly occurring as the axis rises and falls. Let us assume in what follows that no initial velocity existed. Since the rotation of the wheel is becoming slower, and consequently the deviating force a smaller and smaller function of the velocity of the axis, obviously a time must come when this force will be so weakened at the higher levels, where the velocity of the axis is small, as to be unable to bring the path to a cusp. A reversal of curvature will take place and the axis pass through a rounded summit, beginning the second descent with a certain initial velocity. The elevation of the summit will be less than the original cusp since only by a fall could the energy be obtained for this initial velocity. The axis henceforth will be expected to describe a series of prolate cycloids. The prolate cycloids thus resulting, however, become flatter and flatter with successive arcs because the decreasing gyroscopic force is less and less able to raise the axis from its lowest level in each loop (Fig. 4). Obviously the effect of the decreasing gyroscopic force is to ultimately produce a horizontal path, since sooner or later the deflecting force will be only just sufficient to support the axis when moving horizontally with its maximum speed without being able to deflect it upward. The attainment of this path is delayed by the fact that the successive summits being lower and lower there is a continual increase of horizontal velocity. The effect of this is to prevent the deflective force from decreasing as rapidly as it otherwise would. The ultimate result, however, is the production of a horizontal path, the velocity being now uniform and equal to the critical value. If henceforth no further diminution of rotational velocity ensued the subsequent path of the axis would be horizontal, supposing the absence of pivotal and atmospheric friction, the gyroscopic force just balancing the attraction of gravitation. The path would be the unstable horizontal path of the theoretical gyroscope already referred to as resulting when the initial velocity is equal to the critical velocity. The rotational velocity continues to decrease, however, and consequently the gyroscopic force also decreases, becoming now too weak to sustain the horizontal motion. The path of the axis hence inclines slightly downward. The axis gains velocity by the fall, a result which has the effect of preventing the deviating force from decreasing as rapidly as otherwise. The inclined course of the axis continues henceforth, the velocity

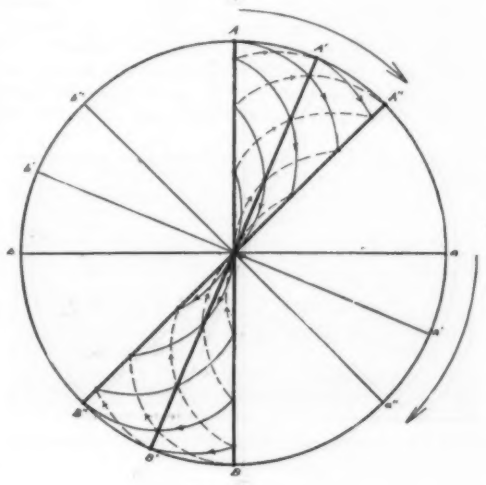


Figure 1

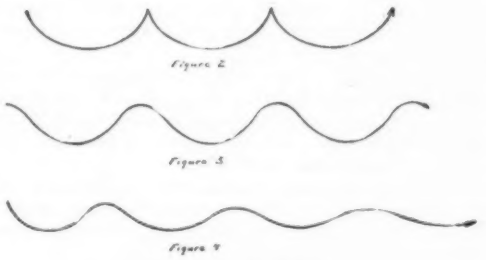


Figure 2.

Figure 3.

Figure 4.

THE GYROSCOPE.

gained by the fall being insufficient to compensate for the continual loss of velocity of rotation of the wheel. The mass of the wheel in falling also supplies the energy necessary to overcome the friction of the pivot and the atmospheric resistance. The subsequent path of the axis winds slowly downward, the rotational velocity becoming less and less and the velocity of the axis greater. The final result would be that the wheel would stop rotating and the apparatus swing around the pivot at a low level, sustained only by centrifugal force, provided the axis did not slip off the pivot or the wheel strike the standard. Within certain limits this helical path is stable and restores itself after a disturbance, since no matter how often interfered with the same factors which produced it are always at work to restore it. This result is in striking contrast with that obtained with the theoretical instrument, as in that case the stable path was the nutating one.

The slowing down of the wheel being the most prominent feature in the action of the practical gyroscope, it follows that under ordinary circumstances this downward non-nutating helical path will be the one ordinarily met with.

(b) Turn now to the effect of friction in opposing the orbital motion. It will be seen that the opposing force due to this cause, acting horizontally, combines with the gravitational force, producing a primary couple constantly directed downward and slightly backward. This, as we have seen before, will continually cause the orbital motion to be directed more or less downward, and the wheel will therefore tend to slowly fall. Owing to the slowness of the orbital motion this action is small compared with that due to the slowing down of the wheel, and cannot interfere with the production of the non-nutating motion just described.

Another curious action due to friction must be considered. As a matter of experiment it is found that if the end of the axis of the gyroscope be raised above the support and then released it will, under certain circumstances, begin to rise. This difference between theory and practice is due to the fact that the apparatus consists of two parts—the first, the wheel, rotating with friction inside the second, the supporting ring, which does not rotate with it. The friction of the axle tends to produce in the mounting a rotation similar to that of the wheel. The mounting, however, is only free to rotate around a vertical axis, as for instance, if the plane of the wheel were horizontal and it were standing with the end of its axis on the pivot. This ideal position is the only one in which the wheel and its frame could rotate together. In all other positions this force tending to produce rotation of the mounting can be decomposed into two couples, respectively about vertical and horizontal axes, the first acting with full effect, while the latter is destroyed at the point of support. If the axis of the wheel is horizontal, the couple about the vertical axis also disappears. If the end of the axis is above the horizontal, this couple about the vertical axis acts in the same direction as the orbital motion. If the axis is below the horizontal, the couple acts in the reverse direction. The result therefore is the same as if an extraneous horizontal force (constantly increasing with the angle from the horizontal) were applied to the free end of the axis, acting in the one case with the orbital motion and in the other against it. The effect will therefore be to cause the end of the axis to rise, if above the horizontal, and to fall, if below the horizontal. The effect just described rapidly becomes unimportant as the rotational velocity of the wheel decreases.

Another action, which occurs both in the theoretical and practical gyroscope, must not be left unmentioned. When the apparatus is in operation and the axis not horizontal, the centrifugal force of the mass around the pivot has some very slight effect. When the axis is raised the result is as though the wheel weighed more than it really does. When the axis is depressed, the result is to apparently lessen the weight. A very slight alteration of the path due to this cause hence occurs, negligible, however, in comparison with the effects of friction.

The action of the practical gyroscope therefore under ordinary circumstances may be briefly summarized as follows: When first released the axis describes a series of cycloidal curves such as the theoretical instrument would describe; in other words, the orbit is nutating. Very soon, however, the effect of friction in slowing down the wheel comes into play, resulting in the transformation of the nutating path into the uniform non-nutating helix already described, wherein the gyroscopic force is just sufficient to counterbalance the attraction of gravitation. Henceforth this path continues until the limits of operation of the apparatus are passed.

THE PROSPECTS FOR LARGE MARINE GAS ENGINES.

CONFIDENCE in the probable use of internal combustion engines for propelling large vessels is not shared by all. An eminent English marine engineer, Francis E. Elgar, in a paper read recently at the Engineering Conference held at the Institution of Civil Engineers, London, was extremely skeptical that such applications would be made, at least for some time to come. His paper included a recapitulation of the characteristics of efficiency, safety and economy, which must be developed and united in this type of engine before it can be successful in marine use on a large scale. His summary, which is worthy of careful consideration, follows:

1. The engine must be reversible.
2. It must be capable of being quickly stopped and started, either ahead or astern.
3. It must be capable of being promptly accelerated to any speed between dead slow and full speed, and of being kept steadily at the required speed for any length of time. "Dead slow" ought not to be faster than one-quarter of full speed, and should be less in very fast vessels.
4. It must be capable of running continuously for long distances, with but short intervals between the runs, without risk of stoppage and breakdown.
5. It must be capable of working well in rough as well as smooth water, or in a seaway in which the variable immersion of the propeller causes fluctuating resistance.
6. All working parts must be readily accessible for overhauling, and all working parts must be capable of being promptly and easily adjusted.

7. The engine must be economical in fuel, especially at its ordinary working speed.

8. It must be compact, light in weight, and well balanced, so as not to cause vibration.

9. It must not involve any risk of accumulation of gas in the ship, such as to form an explosive mixture.

10. Above all, it must be capable of using a fuel whose supply at a moderate price is practically unlimited, and can be readily obtained in any part of the world a ship might visit.

Referring to published plans for installing gas and oil machinery in 16,000-ton battleships, Mr. Elgar maintains that "this exists at present in imagination only." "It is impossible," he continues, "for any one to judge by what has been achieved up to the present in this direction, what weight or space, or what consumption of fuel would be required for the internal combustion engines of greater power, that might, perhaps, ultimately be made to fulfill the onerous requirements of marine work. Engineers and metallurgists may, by working together, succeed some day in overcoming the difficulties of producing large cylinders which will stand the high impulses and great and rapid variations of temperature that occur with internal combustion, but until this is accomplished no great step ahead has been taken."

There are those who will be inclined to consider this view extreme. Many installations of large internal combustion engines have been successful ashore. It is natural to be credulous that in the future engineers may solve the problems of any new branch of engineering. Many times in the past a few years has sufficed to contradict the most distinguished disbelievers.

Another paper read at the conference told of the progress made with the marine steam turbine, which has grown in its application from the tiny "Turbinia" of 1894 to the gigantic "Lusitania" and "Dreadnought" of to-day. A curve showing the total horse-power of steam turbines applied to marine propulsion has its beginning at zero in 1896, and its end at 390,000 horse-power in 1906. It is doubtful if many engineers at the advent of the "Turbinia" expected a turbine propelled "Lusitania" within 10 years. Repeated instances of the sort have bred a confidence in the world's engineering genius, that warrants hope for great ships propelled by combustion engines, in the comparatively near future, and cheaply, perhaps with crude oil, perhaps with alcohol or other clean fuel.

Yet Mr. Elgar's list of qualifications that the engine must possess is by no means unreasonable. It would be difficult to eliminate one of them. Some of the problems have not been nearly worked out in their application in a large sense, and others will require a good deal of advancement before they are completely solved, even for small powers. In large ships the engines must be as safe and sure and economical as the reciprocating engine or the turbine. The large power unit installed on unyielding, immovable foundations in a stationary power plant is surrounded by very different problems from those the marine engineer must face in applying the same type of engine to a large vessel. His difficulties are fully as great as those encountered in the development of the steam engine, and perhaps they are greater, because of the nature of the fuel and of its application to the engine. Great progress has been made with the marine combustion engine, but few will dispute that it is still in comparative infancy. The question is, how soon will it reach the maturity of an accepted type of engine for large ships?—Iron Age.

THE FIRST GERMAN SUBMARINE.

A DESCRIPTION OF AN INTERESTING CRAFT.

BY OUR BERLIN CORRESPONDENT.

THE construction of submarine boats has recently been taken up by German shipbuilders, and after a series of trials on a small model boat, the Germania shipyards at Kiel have just completed a large submarine of 240 tons displacement. The main dimensions of this vessel, constructed on patented designs, are: Length over all, 137.5 feet; maximum width across frames, 11.7 feet; draft of boat when emerged, 7.8 feet; displacement, 240 tons. An electric motor and gas engine, each with an output of 200 indicated horse-power, are fitted to each of the two propeller shafts, the propeller being adjusted from the inside of the vessel. The electric motors are designed for propulsion below water, and receive current from an accumulator battery installed amidships. The battery is sufficient to drive the boat below water for fully three hours at its maximum speed of 9 knots. When on the surface, the gas engines are preferably to be used. The fuel is carried in tanks, arranged outside of the boat (according to patents of the Germania shipyards) thus guarding against explosion. The store carried by the submarine enables the latter to cover a distance of 1,000 knots at her maximum speed of 11 knots on the surface.

The motors can obviously be used also for propulsion above water, while both types of motor can also be used simultaneously for the propulsion of the vessel.

The submersion and emersion of the boat is effected by filling and discharging respectively the ballast tanks arranged inside, as well as by the aid of two pairs of horizontal rudders. The maximum admissible depth of submersion has been fixed at about 120 feet. Only five minutes are required to prepare for submerging the boat.

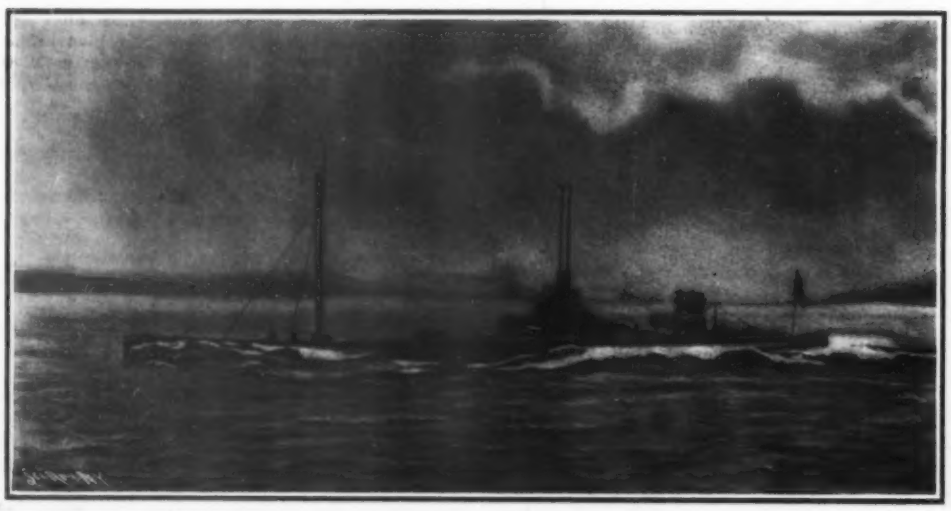
Special care has been bestowed on ventilation, which is secured by an electrically-operated ventilator, which, as long as the boat is above water, will constantly supply all the rooms with fresh air. When submerged, the vitiated air is passed through a cleaning tank, after which it returns toward the various compartments of the boat. With a crew of ten men the vessel is able to sail under water for periods up to 24 hours.

The armored conning tower arranged in the center of the boat and inclosing all necessary instruments, such as viewing apparatus, manometers, rudders, and telephones, is large enough readily to accommodate the commander and the pilot. Two periscopes have been provided, which, both in a vertical and horizontal direction, cover a field of 50 degrees. The length of these inclosing telescopic tubes has been chosen with a view to allow the boat to travel at a depth sufficient to warrant it against gun fire, while still enabling it to cover the whole of the horizon.

THE BOAT SUBMERGED AND TRAVELING AT FULL SPEED.

The armament of the submarine comprises an 18-inch bow torpedo-launching tube. One of the three large-sized torpedoes carried by the vessel is contained in the tube, while the two remaining ones are arranged in water-tight reservoirs.

Trial runs performed in Eckernförde Bay, both in the emerged and submerged condition, have demonstrated the satisfactory sea-going qualities of the submarine.



THE NEW GERMAN SUBMARINE TRAVELING ON THE SURFACE.

RECLAIMING SILVER FROM PHOTOGRAPHIC SOLUTIONS.

By RANDOLPH BOLLING.

IN the process of developing photographic plates and papers the removal of silver iodide and silver bromide from the surfaces unacted upon by chemical rays is usually accomplished by using a bath of sodium hyposulphite. This operation is termed "fixing" in the art and has for its object the clearing of the photographic image and also to maintain the permanency of the plate or paper. The manufacture of photographic plates consists in mechanically imbedding certain haloid salts of silver in a retaining coating of gelatin. It therefore follows that a considerable portion of the silver employed is dissolved in the "hypo" bath which is usually thrown away after its utility has ceased. The silver present is often of considerable value where the dark room operations have been extensive on plates, films, and printing papers. The best and most economical method of working these solutions is to prepare first a saturated solution of ammonium sulphydrate, which is easily done by arranging an evolution flask with suitable delivery tube, gas washing bottle, and a small reagent bottle containing a strong solution of ammonia; any kind of wide-mouth bottles will answer and a few feet of glass tubing and two-hole rubber stoppers arranged so that the sulphureted hydrogen gas evolved is first generated by the action of 200 grammes of iron sulphide on 500 cubic centimeters of dilute sulphuric acid, using 1 part of strong acid to 5 parts of cold water.

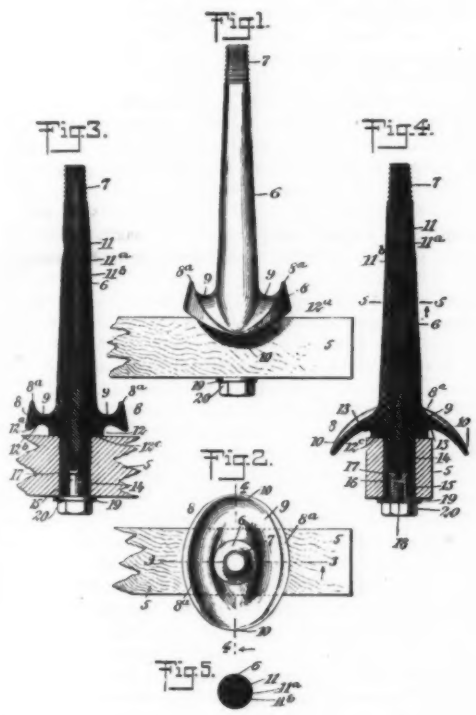
The gas is then conducted through the washing bottle to free it from impurities and then into the ammonia. After a brisk evolution of gas starts from the action of the sulphide upon the acid the ammonia will absorb all and become gradually more and more saturated until after complete saturation bubbles of sulphureted hydrogen will begin to escape in the air. Having thus prepared our reagent for precipitating silver from solutions in which it occurs as a double salt of soda and hyposulphurous acid we can proceed with its precipitation. This is best accomplished by filling an enameled iron kettle or deep dish with all of the old hypo solutions, then heating this to a strong boil and adding ammonium sulphydrate until no further precipitation is noticed. The instant the alkaline sulphide meets the solution, a dense black precipitate of silver sulphide is formed which is insoluble and which will settle very easily if the solution is allowed to slowly cool. After the silver sulphide has completely settled to the bottom of the beaker, kettle, or vessel employed the clear solution must now be carefully decanted off so as not to disturb the silver sulphide at the bottom. At this point it is best to use a glass or enamel ware funnel with a plug of cotton to filter the precipitate on. After all the silver sulphide has been collected on the funnel it is washed twice with hot water and allowed to dry on a warm plate, using a piece of blotting paper to remove the surplus moisture. To reduce the silver sulphide which is now dry it is only necessary to scoop out a cavity on a piece of charcoal which will retain the precipitate and then heat it after giving it a liberal coating of dry sodium carbonate before any sort of gas blowpipe, or simply use an ordinary Bunsen burner with the air shut off and a jeweler's blowpipe. The silver sulphide will react under the blowpipe with the carbon and sodium carbonate and after a few minutes will form a beautiful glistening button of pure metallic silver which is chemically pure 1,000 fine. If it is desired to operate on a still larger scale sodium sulphide can be prepared in the same manner as the ammonia salt, only requiring the

substitution of caustic soda for ammonia, and the employment of commercial sulphuric acid. The precipitation can be performed in the cold, using a large wooden barrel as the precipitating tank, and then siphoning off the supernatant liquid by means of rubber hose or by using an outlet near the bottom of the barrel. In reducing the silver sulphide use a large graphite crucible, powdered charcoal, soda, and a cover of common salt, employing a wind furnace to bring the mass to a fusion. The writer has produced several silver ingots with perfect recovery of all the silver in large bulks of waste solutions.

THREE NEW ELECTRICAL DEVICES.

IMPROVEMENTS IN INSULATORS.

THREE inventions, two of them new insulating devices, and the third a horizontal support for conductors, have recently been patented by Mr. Louis Steinberger, Brooklyn, N. Y. The first, a simple and ingenious insulating pin for supporting conductors carrying heavy currents, is shown in the accompanying engravings. Figs. 1 and 2 show front elevation and plan view of a cross-arm fitted with the pin; Fig. 3 is a vertical central section along the line 3, 3 in Fig. 2, and Fig. 4 a similar section along the line 4, 4. Fig. 5 shows a section through the pin at 5, 5, Fig. 4. A central solid rod, 11, preferably of fiber, dry wood, or other insulating material, is surrounded by a plurality of tubes, 11*a*, 11*b*, also of some insulating material, such as fiber or mica, chosen for having considerable mechanical strength. This composite core is imbedded in, and concentric with, the pin body, its purpose being to confer mechanical strength and to increase the insulating qualities of the body. The pin body 6, terminating at its upper end in a thread 7, is made of some suitable insulating material, preferably electrose. A weather shield, 8, is integral with the body. This weather shield is furnished with a trough, 9, and depressed lips, 10, which shed moisture away from the supporting cross-arm. The shield is further provided with drip surfaces, 12*a*, raised from the cross-



arm by a space, 12, as shown in Fig. 3. This space is annular and forms a dry space round the junction of the pin with the support.

The pin body is provided with an annular shoulder, 12*c*, and with a stem, 14. Imbedded in this stem is a metallic sleeve. This sleeve is placed in position when the stem is plastic, and it is provided with a slot and a flange to hold it more firmly in place. This sleeve is completely separated from the composite core. To place in position the pin is placed in the cross-arm as shown in Figs. 3 and 4, when the shoulder, 12*c*, fits down on the upper surface of the arm, forming a watertight joint which is further protected by the dry space, 12 The sleeve, 15, is threaded inwardly and a screw, 18, with head, 20, is fitted into it and holds the pin firmly in position.

The second insulator device, intended particularly for heavy currents and to prevent arcing from the line to the support, and which provides a number of supporting portions for the conductor as well as means for supporting a number of conductors on the same insulator, is illustrated in Figs. 6, 7, and 8. Fig. 6 is a plan view of the insulator; Fig. 7 is a vertical section through Fig. 6 along the line 2, 2; and Fig. 8 is a perspective view of the lower insulator body without the supporting pin or the upper hood. The supporting pin is shown at 4, Fig. 7, with a vertical boss, 8, threaded externally, rising from a spheroidal upper surface, 7. The insulator body, which may be of electrose, is provided with a skirt, 9*a*, shaped to fit the spheroidal surface of the supporting pin. The insulator body is also provided with a number of radial supporting ribs, 10, each terminating at its upper edge in a flat surface, 11*a*; and with an annular skirt 10*d*. The upper part of the insulator body is in the form of a threaded

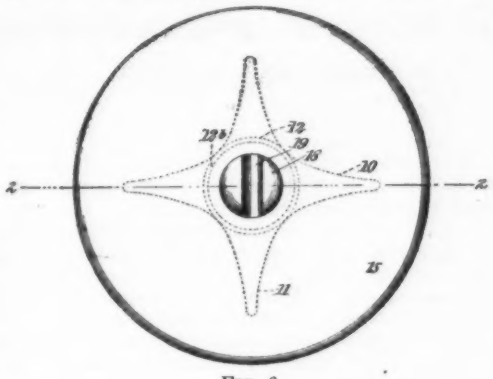


FIG. 6.

boss, 12, with a slot, 14, extending across its top. A groove, 12*b*, encircles the boss and may be used for retaining a tie wire. A hood, 15, Fig. 7, is provided on its under surface with an annular channel, 16,

FIG. 7.

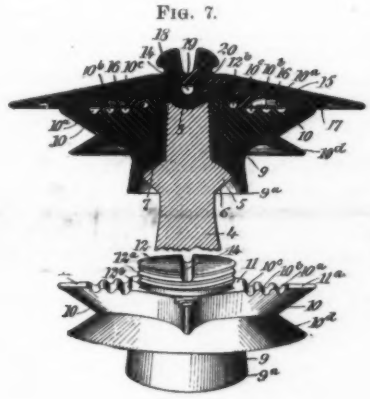


FIG. 8.

bounded by a bead, 17. When the hood is in place this bead fits snugly down on the flat surface, 11*a*; and the channel, 16, arches over the notches 10*a*, 10*b*, 10*c*, in the ribs 11. The hood is shaped into a boss at 18,

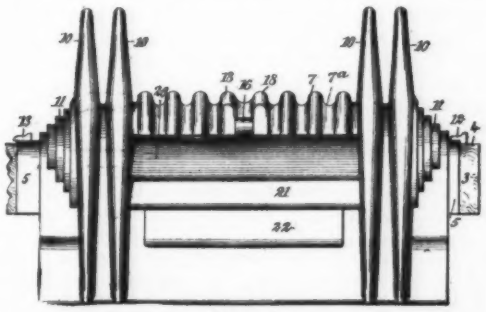


FIG. 9.

having a slot, 19, in which the cable or conductor normally rests, being held in position by a tie wire in the groove, 12*b*. If the boss be broken the conductor may rest within the slot, 14, and be kept in position

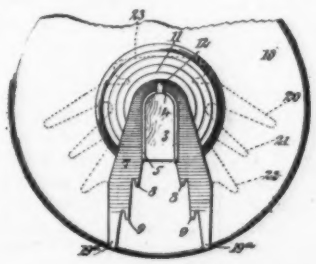
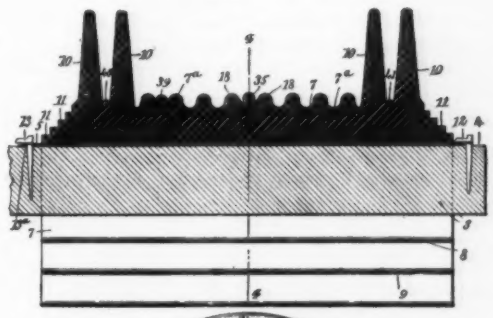


FIG. 10.

with a tie wire in the groove, 12*b*. The notches, 10*a*, 10*b*, 10*c*, increase the surface over which leakage may take place and so tend to diminish surface leakage; they are also available if required as supports for additional conductors. The supporting ribs, 10, receive a part of the weight of the hood upon their upper surfaces 11, 11*a*, and are constructed to distribute its weight as equally as possible with regard to the insulator body, 9. The spheroidal upper surface 7, of the supporting pin, and lower surface, 9*a*, of the insulating material are modeled to fit neatly wherever they engage. By smooth fitting and a careful adjustment for strain a high measure of strength is obtained with a minimum of constructive weight.

The horizontal support for cables, wires or similar conductors, one possessing novel and ingenious features, is shown in the accompanying diagram. Fig. 9 is a front elevation of the insulator, all movable parts being removed; and Fig. 10 is a fragmentary side elevation. Fig. 11 is a vertical longitudinal section through the insulator and its support, along the line 3, 3 of Fig. 12; and Fig. 12 is a central cross section upon the line 4, 4 of Fig. 11, showing the way in which the cable is mounted and its tension controlled. Fig. 10 shows the cross arm, 3, the upper edge of which is rounded and fitted with a metal saddle, 5. Molded rigidly on this saddle is a body portion 7, of insulating material made comparatively thick and provided internally with petticoats 8, 9. The ends of the body portion are provided with steps 11, for the purpose of shedding moisture away from the cross-arm. A num-

FIG. 11.



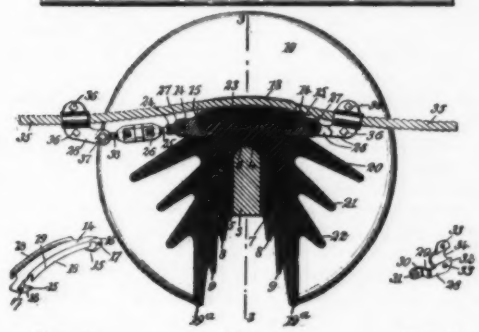


FIG. 13. FIG. 12. FIG. 14.

ber of disks, 10, are spaced apart, there being two of them to each end of the body portion and integral with it. The middle surface of the body portion, 7, is provided with corrugations, 7*a*, these diverting moisture to flow at right angles to the general plane occupied by the cross-arm, and at the same time diminishing the chances of surface leakage.

The saddle, 5, on which the body portion is molded, is held in position by metallic spikes, 12, 13, driven into the cross-arm; these may be driven through the saddle, insuring that no displacement can take place. The lower edges, 19*a*, of the body of insulating material are flush with the lower edges of the disks, 10; the body is also provided with horizontally-disposed sheds, 20, 21, 22, spaced apart for the double purpose of facilitating the drainage of moisture and decreasing surface leakage; and its upper surface is molded into a support, 23, Fig. 12, to hold the wearing plate.

A wearing plate, 14, shown in detail in Fig. 13, is imbedded within the body of insulating material as shown in position in Figs. 11 and 12. A link, 24, attached by a pin to the wearing plate, is provided with a threaded bolt, 25, and connected with this bolt is a revoluble buckle, 26, connected in its turn by a second bolt and pivot to a clamp, 28. There are two of these clamps, one attached to each end of the wearing plate, but only one connected by a revoluble buckle. They are shown in perspective, with their attachments in Fig. 12; they are made in halves and the detail of construction is given in Fig. 14. Each of the clamps is firmly gripped upon a cable, 35, and held in position

thereto and to each other by the bolts, 36. The clamp to the left in Fig. 12 is connected with the buckle, 26, by the pivoted bolt, 38. The bolts, 25 and 38, are threaded oppositely so that the rotation of the buckle tends to tighten or slacken the cable.

In use the cable, 35, rests centrally along the wearing plate, 14, being held in place partially by its own weight. The clamps and turnbuckle are next placed in position and the clamps bolted to the cable. This obviates any chafing of the insulating material, for all wear is borne by the plate. If it is desired to adjust the cable this may be done by turning the turnbuckle, 26, so as to pull the cable in the direction required. By the use of this turnbuckle, with the clamps tightly gripping the cable, the small portion of the cable between the clamps may be made to buckle slightly, thus transferring most of the strain from the top of the wearing plate to its ends. If the cable should break the slack cannot extend farther than the two insulators located on the opposite sides of the break.

The corrugations, 7*a*, not only serve to retard the creep of moisture by breaking up the surface of the insulator, but also serve if required as rests for additional cables. If for any reason the cable, 35, should become detached from its fastening it may still rest between these corrugations.

It will be noted that the disks, 10, taper. Wires may therefore be inserted between them, as 40 and 41, Fig. 11, and wedged firmly in position. Thus a telegraph or telephone wire, or even a so-called "third" wire, may be carried without detriment to the general usefulness of the insulator.

WIRELESS TELEGRAPHY.*

SOME OF ITS PRACTICAL AND COMMERCIAL ASPECTS.

BY WILLIAM MAVER, JR.

PART I.—TECHNICAL ASPECTS.

WIRELESS telegraphy now appears to be settling down on a practical basis. It is finding its important field to be where all those who have not been actuated by interested motives have consistently stated it would be found—namely, as a means of communication between ships at sea and between ships and the shore. How long it will hold this field undisputed depends upon the measure of success that may attend the efforts of those who are now endeavoring to perfect wireless telephony. At least half a dozen inventors are at work on this problem in this country and Europe, and it is reported that the wireless transmission of speech has been experimentally successful up to distances of several miles over land; but apparently much remains yet to be done before wireless telephony, even for short distances, becomes an accomplished fact. Should this hoped-for result be achieved, however, it is evident that for many purposes it will displace wireless telegraphy. For example, probably one of the chief reasons why wireless telegraphy is not already universally installed on all manner of sailing vessels and steamships is the necessity for employing an expert Morse operator to transmit and receive messages. Wireless telephony, even if only available for a comparatively short distance, obviously could be installed to advantage in the officer's room of every ship that floats the ocean, lake, river, or harbor, and perhaps on railway trains as well, for any purpose that might arise.

Wireless telephony is not yet here, however, while fortunately for those that go down to the sea in ships, wireless telegraphy is here, and it is already installed or is being installed on every lighthouse and on the vessels of every important navy and steamship line in the world. It is probably easily within bounds of accuracy to say that there are now over 2,000 wireless stations, including ship and shore stations, in operation in various parts of the world, and this number is being added to daily.

The distances covered by wireless telegraphy in regular operation may be set at from one mile to fifty or 100 miles. When the statement is made, as it frequently has been, that messages have been received from ocean-going vessels several days out from New York, it may be taken for granted that these messages have been received at one or other of the Atlantic coast stations within wireless signaling distance of the vessel, and by those stations repeated by overland wire telegraphy to New York. There is no doubt that messages are received under favorable conditions at distances of several hundred miles away from shore, but these are exceptional cases. No regular interchange of business is at present carried on at those distances.

While we frequently run across the statements of interested brokers in wireless-telegraph stock that transatlantic wireless telegraphy will shortly be accomplished, it is noticeable that Marconi, Fessenden and De Forest have of late been silent on this subject. Fessenden indeed has, with commendable frankness, practically admitted that the difficulties of transatlantic wireless telegraphy are at present well-nigh insurmountable. His experiments were continued for nearly one year between Massachusetts and Scotland. He found that there are at least two serious obstacles in the way of transatlantic wireless signaling. First, atmospheric absorption of the electric-wave energy of the signals. Up to distances of 1,000 miles this absorption is not very marked, but beyond this point it becomes very important. The other difficulty consists in the inability to maintain syntony, or tuning of the apparatus, at the respective transmitting and receiving stations. The difficulty, in the words of Mr. Fessenden, "is in getting the stations which are to communicate to maintain their frequencies sufficiently regularly." It was found impossible to receive messages when the frequency varied one part in 1,000,000. This, it may be noted, is equivalent to saying that if a telegraph system which depended for its successful operation upon the synchronism of wheels at the sending and receiving stations should vary one part in 1,000,000 the system would not operate. While Mr. Fessenden is hopeful that these difficulties will be overcome, the prospect for an immediate realization of this hope is not very encouraging. But fortunately, again, there is no real necessity for transatlantic wireless telegraphy, or cableless telegraphy, as some wireless experts take pleasure in terming it. The Atlantic cables are still doing business at the old stand, and there is every reason to believe that they will continue to do so for many years. Singular as it may seem to some people there is, apart from occasional injury to the cables, no method of telegraphing that is as reliable as submarine-cable telegraphy. The reasons for this are obvious. The cable, year in and year out, works undisturbed by changes in weather conditions. Lightning storms do not affect its operation, and vagrant currents from neighboring and unneighborly electric-traction circuits, or induction from high-tension alternating-current systems, can never approach within harmful distance of its sensitive apparatus. Similar immunity from these disturbing factors in overland telegraphy would, there is no doubt, be gladly welcomed by the members of this association.

Apart from the filings coherer it may be said that the most prominent type of detectors now in use are the magnetic detector employed by the Marconi interests, the carborundum detector employed by the De Forest Company and the various electrolytic detectors of the Fessenden and Shoemaker types. The magnetic detector, the carborundum detector and the electrolytic detector require a telephone receiver for the reception of signals. The magnetic detector was described in the author's paper on "Improvements in Wireless Telegraphy," read before the Indianapolis convention of this association. The carborundum detector consists of a crystal of carborundum which is clamped between two metal electrodes. Otherwise, so far as the arrangement of circuits is concerned, it simply displaces the filings coherer, but does not operate a relay. The electrolytic detector consists of a small cup containing a dilute solution of nitric acid, into which the terminal of a very fine platinum wire is placed. Another wire enters the acid from the bottom of the cup. When current from a small dry battery is passed through the solution by means of the fine wire, polarization takes place and the current ceases to flow in the circuit. Incoming electric waves appear to dissipate this polarization, causing variations in the current of the local circuit, and sounds corresponding to dots and dashes are heard in the telephone receiver.

The De Forest "audion" is also one of the more recently invented wireless detectors. This detector, briefly described, consists of an incandescent filament in a vacuum, shunted by a local circuit in which is a battery and a telephone receiver. Incoming electric oscillations appear to affect the electrical condition or equilibrium of this circuit and set up variations of current therein which are heard as dots and dashes in the telephone receiver. This receiver was fully described in the transactions of the American Institute of Electrical Engineers for 1906.

Another detector which promises to be of utility in practical wireless telegraphy is the silicon detector, the invention of G. W. Pickard. This detector is of the thermoelectric type of wireless receivers. It produces its own electromotive force. Its electrodes are pure silicon and a metallic element of low resistance. The energy of the incoming electric oscillations is converted into joulean heat (C^2R) at the element having high resistance (the silicon), which heat is converted at the contact point into a short pulse of direct current in the telephone receiver; and a long or short continuation of these pulses produces a dash or dot in the receiver. Mr. Pickard states that a fragment of silicon merely held with suitable pressure between two flat-ended brass rods gives excellent commercial results. This detector has the advantage that no battery is required in the local circuit. In sensitiveness it compares favorably with the electrolytic and magnetic detectors, according to tests made by Mr. Pickard. The carborundum detector is about one-half as sensitive as the last-named detectors.

It is interesting to note that the telephone receiver has been found to respond to a single impulse of current of very much less strength than is required to energize the most sensitive wireless detector, and were it not for the high inductance of the telephone receiver, the intermediate wireless detector would not be necessary. At the high frequencies used in wireless telegraphy, however, namely, of the order of 500,000 or 1,000,000 per second, the inductance of the telephone receiver renders it mute.

An improvement in wireless telegraphy that may lead to important results consists in the use of undamped oscillations, with which numerous experiments are now being made by Poulsen, Shoemaker, the Telefunken Company, and others.

In the ordinary "spark" gap transmitter, it is known that between each spark or train of sparks there is a rapid falling off or damping of the amplitude of oscillations; consequently the full benefits of resonance in the tuned receiving circuits are not obtainable. Poulsen's method of obtaining undamped oscillations is an amplification of the Duddell "singing arc" and consists in employing an electric arc of peculiar construction shunted with a capacity (condenser) and inductance of a wireless transmitting circuit.

In Poulsen's device the positive electrode is copper, the negative electrode is carbon. When the capacity and inductance are suitably adjusted, rapid oscillations of uniform amplitude are established in the circuit and thence are thrown upon the vertical wire. These oscillations are broken into dots and dashes in the usual way. Unfortunately, thus far the energy output by this method is low, and it remains to be ascertained whether or not the advantages of uniform amplitude by conducing to a better utilization of resonance will more than offset the disadvantage of reduced energy output.

Another improvement in the practice of wireless telegraphy consists in the employment of electric-wave meters by means of which the wave-length or the wave frequency may be measured. These wave meters are based primarily on the principle that with an exciting circuit in proximity to a secondary circuit, a maximum current will be induced in the secondary circuit when the two circuits are in resonance, which will be when they possess corresponding inductance and capacity. Knowing the capacity and inductance of the secondary circuit, the frequency and wave-length of the oscillations are deducible. (A detailed description of electric-wave meters may be found by those interested in the last edition of the author's work, "Wireless Telegraphy.") Increased familiarity of the operators with the apparatus has also naturally tended to improved results in the actual operation of the various systems. Apart from the foregoing noted features and certain improvements in the details of apparatus and the arrangement of vertical wires, there has been comparatively little advance made in the art of wireless telegraphy during the past one or two years.

A short description of some experiments conducted recently by the Telefunken Wireless Telegraph Company of Berlin, relating to the use of wireless telegraphy between railway trains in motion and fixed stations, may be of interest to the members of this association. The experiments were made on sections of railway track about 12.5 miles in length, with four stations about four miles apart within this distance. The wireless outfit of each fixed and moving station consisted of a filings coherer receiver and an induction coil transmitter, together with the other apparatus usually employed therewith. A coach containing the wireless outfit was equipped with a rectangular wire suspended by posts about one foot high at each corner of the roof of the coach. The wire was attached to porcelain insulators on the top of these posts. A single wire was led from this wire to the apparatus within the coach. A ground was ob-

* A paper read at the convention of the Association of Railway Telegraph Superintendents.

tained through the iron trucks of the coach. The fixed station was between the telegraph poles. The aerial wire was erected horizontally between the poles and paralleled the regular telegraph wires for a distance of 195 feet, about one foot therefrom, and was carefully insulated from those wires. A wire connected this aerial wire to the apparatus in the fixed station. The ground was made by a wire connection to the nearby rails. Current for the induction coil was supplied by eight portable storage cells giving sixteen volts and having an output of about five amperes with a spark-gap of 0.12 inch. The maximum distance of the train from the tracks was sixty-five feet.

By this arrangement reliable signals were sent and received at a distance of 7.5 miles.

As several of the members of this association have had experience with other methods of telegraphing to and from moving trains, they can probably enlighten the association as to the necessity of improvements over those methods, and also as to the utility of such systems in general.

PART II—COMMERCIAL ASPECTS.

The opinion of the writer has been frequently asked as to the merits of the great claims that are being made relative to the dividend-earning capacity of wireless telegraphy by the brokers who appear to have assumed control of the stock-selling end of one or more of the wireless companies. A few remarks bearing on these claims may, therefore, not be inappropriate at this time.

Let us first discuss the wireless telegraph earnings on the basis of the exchange of messages between ship and shore stations. According to the published reports of one of the wireless companies which has its system installed on seventy-eight steamships plying between Europe and the United States, the gross earnings for the year 1906 were approximately $55,170 for messages exchanged between ship and shore stations. This figures out to approximately 25,823 messages for the year, which is equal to a total of seventy messages per day, or less than one message per day per ship. How much, if any, of this revenue goes to the foreign wireless telegraph company that presumably owns the wireless apparatus on the ships is not stated. Presumably also certain royalties may have to be paid by the ship owners for the use of the apparatus, and there may also be additional revenue for "news" service received on shipboard. But granting this, it is difficult to figure out much net revenue after the salaries of officers and operators have been paid.

This is perhaps the best showing that can be made for wireless telegraph companies doing a general commercial business in this country, or with the ships that sail United States waters. When it is stated that hundreds of steamships own their own wireless apparatus outright, and do considerable business with government wireless shore stations without charge, the difficulty of seeing a bright prospect for the earning of dividends on capitalizations amounting to six, eight or ten millions of dollars by a legitimate exchange of wireless messages between ship and shore stations is largely increased.

One of the large German wireless telegraph companies has confined its business almost exclusively to the manufacture and sale of its apparatus outright to customers, and it is understood they have made fair profits. Several companies in this country are doing likewise. Obviously, therefore, there is no monopoly of this art on the part of any one company, although such a claimed monopoly is the chief stock-in-trade of certain of the stockbrokers referred to. An analysis of the published claims put forth by certain stockbrokers to induce the purchase of stock in a wireless telegraph company shows some glaring misstatements, seemingly at least calculated to mislead prospective customers as to the constructional and operating costs, etc., of the system. Another method to induce purchase of stock consists or did consist of sending broadcast by mail circular letters offering stock of a wireless telegraph company at $110 per share, guaranteeing five per cent per annum on the stock for five years. This appears a fair enough proposition until it is known that the stock was at the time offered on the New York curb at $30 to $36 per share.

This offer was accompanied by the most glowing accounts, without regard to the many difficulties in the way, of the prospective earnings of the company, by means of transatlantic wireless telegraphy and by overland wireless telegraphy as well. It is but fair to say that the managers of at least one of the companies whose stock is being used in this way have disclaimed any responsibility in the matter. Unfortunately, it is to be feared that the brokers were only too successful in unloading stock to unsophisticated purchasers on this basis.

The author of this paper has frequently taken occasion to express his admiration for wireless telegraphy as an art and to point out its extreme importance in the field for which it is so well adapted. It should be, however, he believes, as much the duty of one more or less familiar with the facts to point out, when opportunity offers, the limitations of a system, and the erroneous and seemingly misleading claims made in its behalf, as to laud its merits and advantages. This constitutes the reason for the writing of the second section of this paper.

FOOD VALUE OF CORN AND CORN PRODUCTS.

A DIETETIC ACCOUNT OF AN IMPORTANT CEREAL.

ALTHOUGH a native of the new world and first extensively cultivated here, Indian corn or maize is now grown very generally wherever the climate permits. In the United States corn is by far the most important cereal, and is grown in every State, though the southeastern and middle western sections are the great corn regions. The greater part of the corn crop is used for feeding live stock and poultry, or for starch making or other manufacturing purposes. Nevertheless, corn has always been and still is a favorite and very important source of human food in America, and especially in the South Atlantic States, where it ranks with wheat as a breadstuff.

The germ of corn makes up an unusually large percentage of the kernel as compared with most grains, and as the germ is very rich in fat the grain as a whole is characterized by an unusually large proportion of this constituent. The proportion of protein is also fairly high. Carbohydrates, particularly starch, make up the greater part of the nutritive material of corn, as of other cereals. Until about fifty years ago corn was simply ground and then bolted or sifted at the mill or at home in making meal for cookery, but now it is usually kiln-dried and deprived of the outer skin and germ before grinding. The modern granulated corn meal is bolted to free it from offal products and is finer and keeps better than the old-fashioned sort, though it does not differ from it very materially in composition except that it contains a little less fat and crude fiber. The removal of the corn oil modifies the flavor, though it undoubtedly improves the keeping qualities. In general, corn meal contains a little more fat and starch and a little less protein than wheat flour, but after all it resembles this staple foodstuff quite closely in chemical composition.

The changes brought about in corn by the heat of cooking are much the same as those observed in other cereal grains. Thus, the cell walls made up of indigestible crude fiber are softened and broken down and so the starch inside may be more readily reached by the digestive juices. Heat, with or without the presence of water, changes some of the insoluble starch into forms which are easily dissolved, a condition favorable for digestion. Cooking has further advantages in that it improves the flavor of corn and thoroughly sterilizes it, a matter which may be very important under some conditions.

Corn protein does not contain the elastic, tenacious gluten which is characteristic of wheat protein and so corn meal does not give a light porous loaf with yeast. For this reason corn meal alone is seldom used for raised bread, but is usually baked in thin cakes which are granular rather than porous, although such leavening material as eggs, sour milk with soda, etc., may be used in making the batter. When corn meal is mixed with wheat flour or rye flour the dough may be raised with yeast. Such bread, of which "rye and Indian" bread is a typical example, is most palatable when slowly cooked in rather large loaves. Corn meal is often used for making mush or porridge. Under the name "hasty pudding," this dish used to be a favorite in New England and is still frequently served as a supper dish.

Samp and hominy, which are much less finely ground than corn meal, are cooked like other grits and are commonly used as a breakfast cereal or as a vegetable to accompany meat. Hominy is now frequently made without the skin and germ. Like other similar cereal goods hominy and samp require long-continued and thorough cooking, especially when coarse.

Hulled corn is an old-fashioned dish in which the kernels, instead of being ground or degerminated, are steeped in lye until the hulls are loosened, soaked in clear water until free from alkali, and then boiled until soft and tender.

There are various proprietary breakfast foods made from corn. In most of these the grain has been cooked until tender and then rolled or flaked and sometimes parched with or without the addition of malt or other flavoring material.

Small hard varieties of corn when shaken over a hot fire pop or burst to a white, light mass, owing to the sudden expansion to steam of moisture in the cells making up the interior of the grain. Popped corn is sometimes used at table, but is usually eaten out of hand. The total amount consumed is fairly large. Varieties of corn which will not pop are sometimes parched and eaten and are also used as a coffee substitute.

Cornstarch has long been an important foodstuff commonly used for making puddings and desserts and for invalid cookery. Glucose made from cornstarch is a very common commercial product. The use of corn oil as a culinary fat is comparatively recent but seems promising.

Corn meal and other corn products are used in making an endless variety of batter breads, cakes, and other dishes for which recipes may be found in books devoted to cookery.

Unripe or green corn is frequently used as a vegetable, particularly in America. Like all green vegetables it is succulent and contains a small amount of nutritive material in proportion to its bulk, being esteemed for its pleasing flavor and the variety which it gives to the diet rather than for its direct food value. Corn canned alone or mixed with beans or tomatoes is a common commercial product, reasonable in price, and a useful addition to the list of vegetables, particularly in the winter diet.

Careful experiments made to test the digestibility of corn indicate that the carbohydrates are almost completely utilized by the body, no matter how the grain is cooked. The method of preparation, however, apparently makes considerable difference in the digestibility of the protein. Thin, porous corn bread, such as johnnycake, and even the thick loaves of Boston brown bread, made of equal parts of corn, rye, and wheat, furnish as large a proportion of digestible protein as white wheat bread raised with yeast. On the other hand, the protein of hoecake (corn meal mixed with water and baked in thin sheets) has been found to be slightly less digestible than that of wheat bread, while the protein of hasty pudding and boiled hominy is only about 73 per cent digestible as compared with 83 to 86 per cent in the above-mentioned types of corn bread.

The corn breakfast foods and other corn products have much the same digestibility as corn meal when cooked in similar ways. The variations which have been noted with the different corn breads and other corn dishes are of the same character as those observed with similar foods made from wheat flour of different sorts.

Corn, though a wholesome and very useful foodstuff which may be cooked in many ways, is not likely to replace wheat as a leading breadstuff where the latter can be obtained, as wheat bread is commonly considered to be more appetizing for everyday use and has an advantage in that it keeps for a longer time in good condition after baking. Corn breads, however, give a pleasant variety to the diet, and being more easily and quickly made than wheat bread are especially useful when hot bread is wanted and time is limited. Corn breads and corn cakes are so easily made that they are favorites in camps and wherever cooking appliances are few and simple.

Where conditions are especially favorable to corn cultivation, as in the mountain districts of the southeastern United States, some parts of Italy, and the Balkan regions of Europe, corn is often the staple cereal food and not infrequently the principal article of diet for the poor. In times of distress people have lived on this grain alone for considerable periods, but, like other grains, it contains too little protein in proportion to its fat and carbohydrates to supply the body with nutritive material in the proper proportion, and it should be combined with materials rich in protein, such as lean meat, milk, cheese, dry beans, etc. When thus combined it is a healthy, nutritious, and inexpensive food and has been proved by common experience to be wholesome, palatable, and a welcome addition to the diet.

Considering all of its uses, corn is one of the most important cereal foods from the standpoint of palatability, nutritive value, and digestibility. It may be prepared for the table in a great variety of ways, and in some form or other is deservedly used in the majority of American homes.—From a Bulletin by Dr. Charles D. Woods issued by the U. S. Dept. of Agriculture.

The "Mars" battleship has established a record for the port in coaling at Portsmouth. Lying alongside the depot she shipped 1,240 tons in 4 hours 5 minutes.

THE COMPLETION OF CARL HAGENBECK'S NOVEL ZOOLOGICAL PARK.

BY HAROLD J. SHEPSTONE.

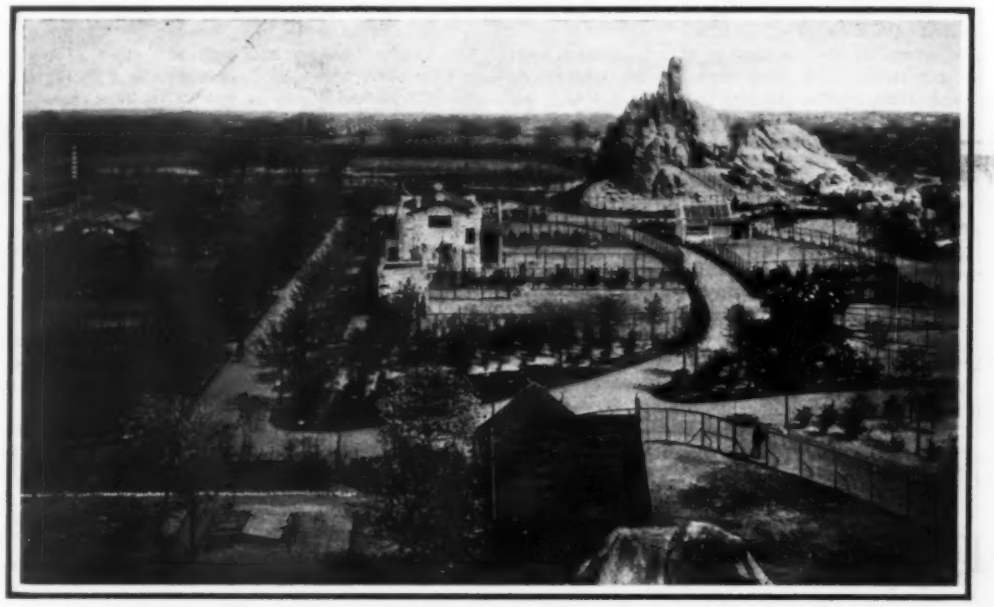
THE great zoological park which Mr. Carl Hagenbeck has been erecting at Stellingen, a suburb of Hamburg, is now completed, and was formally opened a few days ago in the presence of a distinguished gathering of zoological experts. There were present the directors or representatives of nearly every zoological garden in Europe.

In the SCIENTIFIC AMERICAN of November 10 last the writer was accorded an opportunity of describing the park as it then appeared. Any lengthy reference to the inclosures and houses then completed need not be repeated here. At the same time a considerable amount of work has been accomplished during the intervening eight months, particularly in the erection of the restaurants, the artificial mountains, various shelters for the animals, the main entrance gates, etc. Indeed, Mr. Hagenbeck has undoubtedly established a record in zoo building, for the great panorama views of wild life which is the dominant feature of this zoo have all been erected in the comparatively short space of three years.

The gardens occupy thirty-six acres of ground, and are unique for the bold and even daring manner in which wild animals are presented to public view. Entering the park through the main gates—an artistic piece of work ornamented with bronze figures of men and animals—one passes along a shaded walk until the refreshment pavilions are reached, when there suddenly bursts into view a spectacle, the like of which can be seen nowhere else in the world. Immediately in front of you is a spacious lake on which waterfowl congregate. Behind them, on slightly raised ground, are scores of hoofed animals, such as zebras, camels, dromedaries, wild horses, wild asses, yak, alpacas, etc. At the extreme ends of their inclosures are artistically-conceived cave-like shelters, into which the animals can retire in bad weather or out of the heat of the sun. Behind these again, at a slightly higher elevation, come the quarters for the big cats, while immediately behind these rise a ridge of mountains on which ibex, mountain sheep, and goats disport themselves. There are nine distinct peaks towering from 60 to 160 feet in height, and looking for all the world like a slice out of the Alps.

Intersecting paths allow visitors to secure a close view of the animals. Thus, one can stand in front of the lion house, and watch lions and tigers in a space measuring 60 feet by 45 feet without any obstruction whatever interfering with one's view. The animals are confined to their den by means of a broad ditch, which cannot be detected from the public footpath. Visitors asked so many questions about this ditch, which is hidden from their view by a narrow strip of garden, that the proprietor has now erected a turnstile, and for a small fee one can pass right to its edge at one corner of the den. The distance from the animals' side of the ditch to the public footpath is 30 feet.

Above the lion house, Mr. Hagenbeck is now placing a number of the larger birds, such as vultures, eagles, and owls. They have each little rock shelters, into which they can retire, and are kept in captivity by long, thin steel chains attached to their legs. It is quite a novel spectacle to watch an eagle mount into the air and then alight on an adjoining pinnacle, appearing from a distance to be perfectly at liberty.



GENERAL VIEW OF THE PARK, SHOWING THE ARTIFICIAL MOUNTAINS FOR MOUNTAIN DEER AND SHEEP. THE "MOUNTAINS" TOWER 160 FEET ABOVE THE SURROUNDING COUNTRY.

The artificial mountains which rise behind the lions' quarters are nothing less than imitated masses of rocks piled one on top of the other. But no garden can boast of such high mountains, and to the surprise of many zoological experts, they have been found to be ideal homes for the animals that inhabit them. Indeed, to watch the mountain sheep, goats, and deer jump from one precipice to another is one of the favorite pastimes of visitors.

Another interesting panorama view of animal life is that where a number of Arctic animals have been quartered. It is immediately to one's left as you stand in front of the large water lake facing the lions' quarters and the mountain ridge described above. First comes a large basin in which seals, sea-lions, penguins, and other Arctic fauna disport themselves. Immediately behind them at a higher elevation four magnificent polar bears find a home, a broad and deep ditch preventing them from getting at the seals in the pond below. It is amusing to watch a bear suddenly detect a seal below him in the water and make a dash toward it, and come to a sudden stop on the brink of the ditch. The bears' home is very novel and quaint, and from a distance the animals appear to be climbing a stranded iceberg. To the left of the bears' quarters are a number of reindeer. The whole structure, too, can be ascended on one side by means of a winding stairway, from which a magnificent view of the gardens is obtained, and descended on the other by means of a Canadian tobogganing slide.

THE LIONS' QUARTERS, SHOWING ALSO HOW THE LARGER BIRDS ARE KEPT AND THE ROCK WORK ABOVE. THE EAGLE SHOWN IS PREVENTED FROM ESCAPING BY A LONG CHAIN ATTACHED TO HIS FEET.

The restaurants in the park are probably the finest ever erected in any zoological garden. The two principal dining rooms can seat at one time 700 persons, while the walls are decorated with a collection of horns, heads, and antlers valued at over $15,000. Indeed, this is the finest private collection of horns ever got together. Then there are a number of private dining rooms and dining-room suites for parties. The restaurant rooms are so designed that one can dine in them, and glancing out of the window obtain the panorama views of wild life already described. In all, some 600 wild animals, birds, and waterfowl are presented to view from the refreshment pavilions.

In addition to these novel displays of animal life, there are some fine animal houses in the park. The principal one is a magnificent and artistic structure, affording accommodation for over 200 various beasts. The eastern portion of the edifice is given over to the elephants, where sixteen of these giant creatures can easily be housed. On the west side there are five large divisions for hippopotami, rhinoceroses, etc., and sixteen stables for large and small antelope. The south of the building contains upward of forty cages for the larger cats. The center of the building, lighted by a large glass dome, is known as the training establishment, and here visitors to the garden can watch how animals are taught to do all kinds of tricks for show purposes.

Mention may also be made of the reptile house, which contains a goodly representative collection of snakes and reptiles. There are some fine specimens of the bigger snakes, such as pythons, boa constrictors, etc. There is also a giraffe house. In a handsome annex to the large central building there are to be seen two young gorillas from the interior of Africa, a chimpanzee, six orang-outangs, a spider monkey, and a Kulukamba monkey. For the ordinary species of monkeys an elongated structure has been erected in the gardens, consisting of twenty-four sections.

In the eastern portion of the park we find the ornamental garden. Its principal attraction is a large lake, in the center of which is an island. The latter is connected with the mainland by two handsome light bridges of oak. The lake contains water lilies and other aquatic plants, and is replete with beautiful large goldfish, gilt-heads, gold-carps, gold-tench, and Japan-

ese hugoys, a carp-like fish six to twelve inches long.

Other interesting novelties of this animal's paradise include a playground for children, where they can disport themselves in gymnastics or games of all kinds. To provide further amusement for young and old, Mr. Hagenbeck has arranged for a number of elephants, dromedaries, camels, small ponies, and zebras to be available for rides. When the writer left the park, arrangements were being made for the erection of a group of native villages. They will be populated by races from all parts of the world.

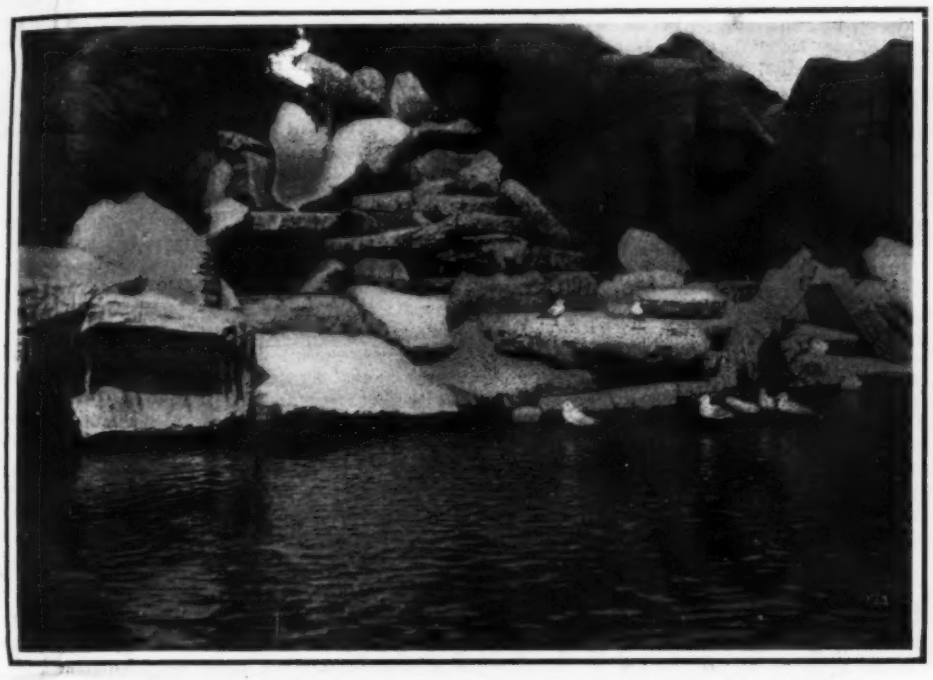
As to the animals in this wonderful zoo, to give an idea of the number of beasts seen there, one has only to add that it is the largest collection ever got together. At the time of the writer's visit there were 53 lions in the park, 7 Bengal tigers, 4 snow leopards, 4 Indian rhinoceroses—an animal which has not been in the market for twenty-five years—3 African elephants, 9 baby elephants, and other wild beasts more or less in proportion. Indeed, the value of the animals alone is put down at $250,000.

INDUSTRIAL USES OF CASEINE.

THE FUTURE OF A STRANGE SUBSTANCE.

BY D. SIDERSKY.

In the former system of butter making, based upon the process of hand skimming, a buttermilk having a considerable alimentary value was obtained and could be well used in the preparation of certain cheeses on account of the fact that a certain amount of fatty matter remained in the skimmed milk. The use of such buttermilk was made easier, seeing that butter was generally made on the farm and small quantities of milk were used. With the introduction of centrifugal apparatus for mechanical skimming and the development of the butter industry which concentrated the work in special factories and operated on large quantities of milk, the problem of utilizing skimmed milk became more complex. The skimmed milk of the centrifugal apparatus, which contains only two parts in one thousand of fatty matter, is no longer good for the manufacture of cheeses, and the large quantities now produced could not all be absorbed by feeding stock. For this reason, manufacturers had the idea of extracting albuminoid matters or caseine from the skimmed milk, whose proportion was almost as high as that of the fatty matter of fresh milk.



THE POLAR BEARS' DEN, SHOWING ALSO THE POND FOR SEALS AND SEA LIONS.

The caseine industry commenced in the United States about fifteen years ago. Owing to the success of the trials made for substituting caseine for gelatine in the preparation of sized paper, the new industry developed rapidly, on account of the low price of milk in the great cattle raising centers. Soon the American manufacturers began to introduce a part of their production upon European markets, where the home production was just commencing, and thus put a drawback upon the new industry by lowering the prices. In France, the production of caseine commenced about 1897 and developed quickly. But soon the price of caseine fell from 120 francs the 100 kilogrammes ($0.53 per lb.) to 70 or 80 francs ($0.30 to $0.35 per lb.) on account of American competition. Statistics show in fact that the imports of this product increased considerably from 1898 to 1902. Considering that this was a drawback to the butter industry, the legislators in France established a duty of 20 francs minimum and 30 francs maximum per 100 kilos of caseine ($0.08 to $0.12 per lb.), and this duty was applied since June 24, 1905. On this account the industry developed under better conditions in France, and it is even exported at present.

Extraction of Caseine.—The different processes of extraction of caseine from milk are based upon the precipitation by acids, and it is but seldom that the method of pressing is used. According to the quality of product which is desired, we make use of sulphuric or hydrochloric acid, or the lactic acid which is formed spontaneously in the milk by fermentation. The caseine produced by the latter process is the most desired. Generally we treat the skimmed milk with sulphuric acid added in the proportion of 10 parts at 66 degrees strength diluted in 50 parts of water, for 5,000 parts of skimmed milk, previously heated to 47 or 48 deg. C. The coagulation takes place at once, and by means of a thorough stirring, the caseine precipitates in rather large flakes. After a short settling we siphon off the whey as well as possible and then wash the curds in cold water to take off all traces of acid. When the water is removed, the caseine is placed in cloths which are folded over, and it is put under hydraulic pressure. This further purifies the material, which appears as a soft white mass resembling lightly-wet cotton well packed down. The mass is then ground up and spread upon metallic gauze frames which are superposed in a wood drying chamber having a current of hot air circulating by means of an air-fan. The drying takes place at a rather low temperature, about 50 deg. C., and it is completed at the end of 24 hours. The dried caseine is passed into a roller mill and the powder thus obtained is sifted or bolted according to what kind of final product is desired. To obtain a very pure caseine, some manufacturers first free the skimmed milk from the small quantity of fatty matter which it contains by rendering it alkaline by soda and passing it into the centrifugal machine.

Caseine is found in commerce in different degrees of purity, according to the industrial uses for which it is desired. Dr. Fascetti has analyzed a great number of commercial caseines, determining the water, nitrogenous matter, non-nitrogenous organic matter, and ash, decomposed into their respective elements, phosphoric and sulphuric acids and lime. He finds that the amount of water varies from 6.10 to 12.30 per cent, and the ash from 1.22 to 7.58 per cent. Similar variations occur for the other elements. Thus the albuminoid matters vary from 70.31 to 84.76 per cent and are always below the total quantity of organic matter. His analyses give the following average for industrial caseine: Water, 10.20; organic matter, 85.45; ash, 4.35 per 100 parts, counting albuminoid matter, 75.65; nitrogen, 12.12; phosphoric acid, 1.90, and lime, 1.88. A high proportion of ash is not always taken as a drawback and for certain uses such as the manufacture of lactite, a caseine rich in mineral matter is preferred. On the contrary, the presence of certain organic elements such as milk sugar favors the decomposition of caseine on account of fermentations which occur. As industrial caseine does not become soluble except after a certain preparation, that is, the hydration by means of alkaline or alkaline salt solutions, some of the German and Dutch establishments deliver soluble caseines of variable composition to commerce, which are richer in water and mineral matter than the usual kinds. The commercial value of a caseine depends upon its purity, that is, the proportion of albuminoid matter, determined by an analysis of the nitrogen.

Uses of Caseine.—The adhesive properties of caseine are utilized in a great number of industries of which we may mention several. In the paper industry, adhesive matter occupies a prominent place, for uniting sheets of paper in the desired thickness, for preparing a determined form from a mass of paper, or for coloring or varnishing objects in paper so as to protect them from dampness. For all these uses we employ caseine

PORTION OF THE PUBLIC DINING ROOM AT HAGENBECK'S ZOOLOGICAL PARK. ANIMALS' HEADS ARE USED AS DECORATIONS.

THE COMPLETION OF CARL HAGENBECK'S NOVEL ZOOLOGICAL PARK.

which has been previously made soluble in slightly alkaline water. By adding a small amount of formic aldehyde to the caseine solution and varnishing objects with such solution, they are made impermeable by a simple exposition to the air. In this way are prepared waterproof boxes, and washable paper collars, etc. With paper pulp soaked with a caseine solution we obtain vessels of different forms and sizes, trays for photography, etc., which are made waterproof by means of formol. For stereotype use such paper is employed; and it is light and durable. Thus it will be seen that there is here a wide field of usefulness for this product.

The wood-working industry also uses caseine, either as an adhesive matter or for conglomerate matter. For gluing boards, using a high pressure and heat, a liquid adhesive compound is prepared with caseine, slaked lime, and silicate of soda. The same liquid serves as an agglomerate for the masses which are prepared with sawdust to which different kinds of matter is added, and this is compressed in molds to obtain artistic reliefs. Messrs. Rauppach and Vogel prepare a special glue for wood by mixing wet caseine with ammonia so as to give a gelatinous consistence. The surfaces to be joined are spread with this glue and are allowed to dry for a few minutes, then they are moistened with milk of lime, when the surfaces are joined and are given the proper pressure. After a few minutes the desired effect is obtained and the wood block thus formed can be worked.

Glues made with caseine mixed with lime, plaster, etc., give a series of varnishes which are very resistant to heat and moisture. They can be used to cover walls, for filling holes in vessels and giving tight joints for boats.

Caseine is used to advantage for painting, and the processes employed vary with the requirements. For instance a mixture of equal parts of powdered caseine, slaked lime, and resin is made, adding a solution of zinc sulphate or aluminium and 5 or 6 per cent of Meudon whiting. This gives a very durable paint which can be colored as desired by the addition of mineral colors.

In the textile industries, caseine is used as a mordant for tissues, and it replaces gelatine to advantage in treating tissues. In lace manufacture and tissues of high value, caseine is substituted for white of egg. The same is true for the preparation of glazed paper, where the use of caseine makes the polishing of the surface easier and gives better impressions. For enameling of positive photographic papers, hydrated caseine is used to advantage, and 33 parts of it are mixed with 4 parts tribasic phosphate of soda and 100 parts water. To obtain a photographic emulsion, caseine is dissolved in water containing a little citric acid, with glycerine added.

Plastic Matter.—Caseine dissolved in alkaline solutions serves for agglomerating the residues of different industries, such as powdered cork, with which varied objects are made. In such objects there is, however, but little caseine, but even here the consumption of the product is appreciable owing to the great development of these industries. Other kinds of plastic matter are prepared directly with caseine mixed with various chemical products, and serve to imitate marble, ivory, onyx, etc. These materials are designated under the names lactile, galalith, etc. They are almost unchangeable, inodorous, and incombustible. By working them in the lathe a variety of objects are made, such as billiard balls, buttons, umbrella handles, combs, napkin rings, etc. To prepare the lactile, hydrated caseine with a little water added is mixed with one or more of the following substances: acetate of lead dissolved in acetic acid, alum, borax, copper sulphate, soap, gelatine, talc, tannin, starch, coloring matter, etc. The whole is mixed for three-quarters of an hour in a special apparatus so as to give a homogeneous mixture, heating slightly at the same time and drawing off the liquid which separates. When the mass comes to a pasty consistency, it is put in a centrifugal dryer, then finally dried and sometimes treated with formic aldehyde. Lastly, the mass is compressed in a hydraulic press so as to form it into slabs. Sometimes the product is run into molds so as to form small objects or ornaments.

To make transparent objects, it is necessary to first prepare a clear solution of caseine. According to M. Spitler, this is secured by dissolving the caseine in water containing a little caustic soda and adding successively in small quantities a 5 per cent soda lye, which gives a bulky precipitate. This deposits rapidly and is separated by filtering. From the filtered liquid the caseine is thrown down by a little acid, and it is washed in cold water until it is neutral. Caseine thus treated gives clear solutions, and it serves as the starting point in the manufacture of galalith.

Use of Caseine for Clarification of Wines.—Albuminoid matters are added to inferior wines in order to clarify them by forming a tannic precipitate which draws down all the mechanical and bacterial impurities. The substitution of caseine for white of egg has been the subject of exhaustive researches made by the eminent French chemist M. Münz. Among the different varieties of commercial caseine, he prefers the kind which is prepared by the Hatmacker process, which is very white. It is dissolved in tepid water in the proportion of 5 or 6 per cent. The amount used is 5 or 6 grammes per hectoliter of red wine (75 to 90 grains per 26 gallons) or 4 grammes for white wine (60 grains). The clarification is excellent and the decoloration is but slight. As to the cost, it does not exceed $0.01 per hectoliter of wine.

While the use of white of egg is five or six times as much, Dr. Fascetti, who has specially examined this question, recommends the use of a weaker solution of caseine, not exceeding 3 per cent, and prepares it as follows: Powdered caseine is sprinkled with water heated to 40 or 50 deg. C., and the caseine becomes hydrated and swells up, then it dissolves entirely, forming a white opalescent liquid. After cooling, it is added to the wine and the whole is let stand for one day. A fine precipitate is formed, which deposits rapidly, giving a good clarification, and the color of the wine becomes brilliant. Dr. Fascetti found by experiment that for an initial acidity of the wine representing 5.47 parts in 1,000 (expressed in tartaric acid), the clarification by caseine gave a diminution of 0.74 part, on account of the precipitation of a certain quantity of tannin. With more concentrated solutions, the clarification does not succeed as well and the color is changed.—A paper read at the second Congress of Milk Industries, Paris, France.

THE AEROPLANE.

THE LAWS UNDERLYING ITS PHENOMENA.

TEN or fifteen years ago authorities writing on the subject stated that if only it were possible to make engines so light as to weigh but 10 pounds per horse-power, there would be no difficulty in constructing a flying machine. A few years after, petrol engines were made of such a weight. To-day they are made, and on the market, weighing no more than 2½ pounds per horse-power!

Skeptics used to say that it would be impossible to raise a large apparatus off the ground by engines and propellers. To-day this has been accomplished, not once, but on many different occasions. They also urged that, once in the air, it would be impossible to balance the machine in steady flight. Now, although this has proved somewhat of a stumbling block, we hear of men maintaining themselves for half an hour at a time in mid-air while being propelled along at a great speed. Many have declared the landing would be a difficulty, but, even without considering these recent flights, we know that thousands of glides have been made with man-carrying gliding machines that have almost always ended satisfactorily.

It is necessary for those who would design an airship—and many minds are now being concentrated on that objective—to make some study of the principles of aerodynamics. The science of aerodynamics, that is to say, the study of the reaction of the air on bodies moving through it, has only recently been seriously taken up. It is now pretty well decided that the pressure (in pounds per square foot) exerted on a surface moving against the air is somewhere about 0.003 times the square of the velocity in miles per hour. It has been proved that the size and shape of the body may make some difference in the relative pressure per square foot, as may the velocity when considering very high speeds. What we are now considering is the pressure developed on a plane surface moving at right angles. But when this surface is inclined, other complicated calculations come in.

Chanute, summarizing the conclusions of many experimenters, has shown that the formula of Duchemin, $P = 2P^1 \sin \alpha \div (1 + \sin^2 \alpha)$, is probably about correct, as the proportion between P, the pressure on an inclined surface, and P^1 that on the surface if placed perpendicular, α being the angle of inclination of the surface.

But, even with such formula before us, it is by no means easy to calculate what speed must be given to an aeroplane in order to support a given weight. Theoretically this can be done straight off, but in practice it is different.

Let us start by taking a flat piece of paper. If this be held horizontally and dropped, it ought, according to theory, to fall directly downward at a given rate. Now see what happens. It is evident that, drop it as carefully as we like, it will always start swaying about and moving from side to side till it falls over. In looking for a cause for this, we find a fact, which has been investigated by Langley and others, that with an inclined surface the center of pressure is not in the center of the surface, but toward its front edge, and that the more the surface is inclined, the further, up to a certain point, does this center advance. This is known as Joëssel's law, his formula being $C = (0.2 + 0.3 \sin \alpha) L$, when C equals center of pressure, L the length from front to rear, and α the angle of inclination.

This being the case, it is easy to see that directly our sheet of paper while falling moves toward one side or other (and as its edge offers so little resistance it is very liable to do so), then instead of meeting the air at right angles, as in falling perpendicularly, it meets it at an angle.

But by Joëssel's law the pressure will then advance toward the front, instead of being in the center of the surface, and this must cause the advancing edge of the paper to turn upward. When the paper is thus tilted the center of pressure moves back, and the paper will tend to resume its former position. So we obtain a swinging pendulum action which increases more and more.

If we take an oblong piece of paper, narrow in proportion to its length, this action becomes so intense that the paper when dropped will spin rapidly about its longer axis. On trying different shaped pieces of paper, we soon find several facts. The narrower the paper in proportion to its length, the faster it spins. We also notice that such an arrangement falls comparatively slowly to the ground. But we also may note that it always falls at a fixed angle. The narrower the paper the steeper the angle of fall—about 45 deg.

Now, if we want the paper to fall steadily it will be found that, unless we suspend a heavy weight below it, it is necessary to let it fall sideways—by arranging the center of gravity toward the leading edge. Then the paper will fall in an inclined direction as before, but if the weight be on the center of pressure as shifted it will fall steadily at the given inclination. However, this shifting of the center of pressure is, as we have seen, dependent on the angle of inclination. Taken as a general rule, we find experimentally that if the center of gravity be at a point just about one-third (but more correctly 0.3) of the width of the paper, the latter will glide down fairly stably. Working this out by Joëssel's law, α should equal nearly 30 deg. Here is a piece of paper to which a string is attached exactly one-third across from the edge. It is so weighted that when suspended by this string it hangs just horizontally; on starting this with a slight push forward it will glide nicely through the air.

But this gliding is not well explained. One might have expected this paper to fall down at an angle of 30 deg., whereas what it does is, after falling a certain distance and getting up a certain speed, it goes horizontally and even rises in the air. This, again, is due to the pressure coming gradually more to the front as the speed increases. And I have here another model which may seem at first to show some inexplicable effects. It is usual to consider an aeroplane as a plane surface driven against the air at a certain definite inclination, which results in a certain pressure on the under surface. In fact, it is considered to be precisely the same action as that of the wind on a kite. But now in this case you may observe that there are three planes one behind others, each of which is set at a small negative angle—that is to say, each plane points slightly downward. Yet, on pushing this forward, it will be seen to travel horizontally and even to rise. This would seem to imply that it is not necessary for the air to impinge upon the under surface, but that some action is caused on the top of the plane.

Another point, which we find by experiment, is that narrower planes are more efficient than wide ones.

Another important fact in aerodynamics, unknown till Langley demonstrated it some fifteen years ago, is that a plane surface propelled horizontally through the air will fall more slowly than one falling vertically without progressing. This fact may sound peculiar, but it is easily explained. With the falling plane, the air is pressed away from the under surface and has to find its way round to fill the vacuum which would otherwise be formed above. This takes time, but before the requisite time has elapsed, the plane has moved forward and has a fresh lot of air to deal with. Langley only experimented on speeds up to about 45 miles an hour, and it would be very instructive to know what the results would be at higher speeds. This is a very important law as affecting aerial machines—for it implies that by traveling very quickly we can obtain great lifting power. The discovery of this law is one of Langley's great achievements.

Lilienthal first pointed out, or rather laid stress on the fact, that slightly curved surfaces, concave underneath, were more efficient as sustainers than flat planes. Notwithstanding the theories he advanced, the exact action of the air on these concave surfaces is not well understood. It has also been shown that when the concavity is pronounced near the front edge, that is, while the section of the surface is thus, a revolving eddy is formed under the front part, which seems to assist the whole to progress forward.

But, again, we have to look to the upper side as well as the lower, and here we find a very odd effect. The air striking, or struck by, such a curved convex surface is thrown off upwardly, so that a partial vacuum is formed. This is well instanced by a little toy consisting of a light ball, against which a jet of air is blown. The ball remains suspended at a certain distance above the orifice of the jet. But now if the jet is inclined to, say, as much as 60 deg. with the horizon, the ball still remains suspended and does not fall to the ground. This is not easy of explanation, but must be due to some such cause as that referred to above. To summarize these facts, we find that with a body (say, of a bird shape), parts of which are horizontal or inclined at a small inclination, driven rapidly through the air, the faster it travels, the slower is its rate of fall. The portions of the body at a small degree of inclination are pressed upward with a considerable force. The upper curved surfaces tend to cause a partial vacuum above, sucking the body upward, and the concave parts beneath only tend to lessen the forward resistance. All these favor the action of a flying body. Here is a table summarizing recent trials, from which important facts may be gathered as to the power, speed, and surface necessary to raise a given weight off the ground. All the machines are of much the same general type. All consist of one or more aeroplane surfaces, driven by a single screw propeller, about 6 feet diameter, mounted on wheels to run along the ground. The weights vary from 1 pound to 3 pounds per square foot of sustaining surface. The speed is from twenty to thirty miles an hour. This speed is very low compared to what one would expect an efficient machine to have. At such a speed, the pressure on a vertical surface would be from 1 pound to 2 pounds per square foot, whereas if the speed were increased to 60 miles an hour the pressure would be 10 pounds per square foot.—From a paper read before the Society of Arts, by Maj. B. F. S. Baden-Powell.

AEROPLANE MACHINES.

	Span, Feet.	Area, Square Feet.	Total Weight With Operator, Lbs.	Engine, Horse Power.	Propeller.		Speed Attained, Miles per Hour.	
					Diameter, Feet.	Revolutions per Minute.	On Ground.	In Air.
Wright	40	480	925	24	8	....	....	38-40
S. Dumont (1)	39	560	550	50	6	1,000	24½	22-26
S. Dumont (2)	36⅙	146	500	50	6½	..	25	.....
Bleri	25⅓	140	600(?)	24	5½	....	.	.....
Delagrange	32	645	638	50	6.9	1,500	.....	15
Vuia	..	215	605	....	7¾	...	.....	....

THE MARINE STEAM TURBINE.

A RECORD OF EXPERIENCES.

IT is reported that in the early days of the Royal Society, King Charles II., of amorous memory, posed the Fellows with the conundrum as to why the addition of a live fish to a bowl of water caused no increase in the total weight of this bowl and its contents. The interesting problem thus submitted is said to have given rise to animated debate, various explanations being proffered. Had not the Society been the corporate representative of the "new philosophy," the discussion might have continued as learnedly and indefinitely as that of the mediæval schoolmen on the equally nice point as to the number of angels which could find accommodation on the point of a needle. Appeal to experiment, however, being the essence of the "new philosophy," it was gravely decided to submit the supposed phenomenon to actual test, with the natural result of establishing its non-existence. We are reminded of this historic incident by the numerous explanations which have been advanced to account for the presumed fact that turbine steamers lose speed in a seaway to a greater extent than ships fitted with reciprocating engines. Quite plausible reasons can be found as to why turbine steamers should labor under this disadvantage; but, after all, it is well to be certain that they really do so before much time and energy are expended in divining a sufficient cause for the presumed disability.

Unfortunately, the general engineering public cannot submit the point in question so easily to the test of experiment as in the case cited above, since commercial considerations have led to great reticence, both in the case of builders and owners, as to the actual results obtained with turbine boats on service. Undoubtedly, however, the widespread conviction as to the inferiority of the turbine steamer in this regard has originated in the talk of the navigating and engineering staffs of these vessels, and it is difficult, therefore, to believe that it is entirely without foundation.

On the other hand, Mr. R. J. Walker, in replying to the discussion on his recent paper presented to the North-East Coast Institution of Engineers and Shipbuilders, was able to show that in some instances, at any rate, the turbine-boats have exhibited a remarkable superiority to their rivals, in the very point under discussion. Last winter, he states, the twin-screw Chanel steamer "Sussex" was, owing to stress of weather, unable to leave Dieppe till about twelve hours after her proper time. Two and a half hours after she had started, the "Brighton," which is a turbine steamer, also left Dieppe, and her passengers caught the same train to London as those of the "Sussex." It appears, in fact, that no matter what the severity of the weather, the turbines do not require to be eased, and are not eased save on direct orders from the bridge, dictated by the necessities of the ship, and not those of the engineroom. On the other hand, as is well known, it is necessary to slow down, and stand by, with reciprocating engines in very bad weather, or they might be wrecked by the racing of the propeller. Possibly an explanation of the contradictory reports which are prevalent in this regard may be found in the turbine being superior in really heavy weather, but losing speed as compared with its rival in more moderate seas.

Another factor in the question which may be at least partially responsible for the prevalent opinion is that in service the turbine-boats never show the same superiority over sister vessels in the matter of fuel economy as they have done on trial. The principal reason for this would appear to lie in the circumstance that at full speed reciprocating engines are being over-driven, while in the case of every turbine ship, of which data have been published, it is obvious that even at full speed the turbine is still far from exerting its maximum power, and could easily dispose of more steam if it were forthcoming from the boilers. Further, as marine turbines are always under-speeded, the faster the ship travels the more economical does the turbine become, so that on trial it is working at its best efficiency, while the reverse is the case with the reciprocating engine. The full advantage is never obtained from running the turbine more nearly at its correct speed, independently of propeller considerations. It is certainly possible to maintain it at its full speed of revolution, however bad the weather, as emphasized by the Hon. C. A. Parsons before the Institution of Naval Architects at Bordeaux in June, 1907, but if it should exceed this speed by a small margin, the automatic cut-out would come into action, an occurrence which never happens in service. Hence this source of efficiency is eliminated, and the full effect of the over-speeding of the screw due to the greater slowness of the ship is felt on the steam consumption.

At the Engineering Conference, Prof. Biles stated that in smooth-water trials the Midland Railway Company's turbine boats showed an economy of 15 per cent in steam consumption, as compared with the sister vessels with reciprocating engines, although no difference appeared in actual service. His explanation was that the extra revolutions demanded to maintain speed in rough water loaded the screws beyond the cavitating point. With the large screws of reciprocating engines this effect did not occur, and if turbine vessels were fitted with larger screws, although the trial-trip efficiency might be reduced, better results would be obtainable in everyday work. If this view be correct, and the propeller losses increase so much more rapidly than the efficiency of the turbine increases, for the same speed of the vessel, it certainly seems that the propellers are worked too near their limits of thrust. Sir William White pointed out that falling-off of speed had also happened with reciprocating engines; but the cases are not strictly comparable, as we have pointed out above. As regards efficiency, it is stated that H. M. turbine cruiser "Amethyst" is doing better than her sister ship the "Topaz," with reciprocating engines, and she certainly gave better trial results; but, on the other hand, the German turbine cruiser "Lübeck" has proved consistently worse than the "Hamburg." It is said, however, that other factors enter into this last comparison.

The extent to which ships have been "over-turbined" has been very remarkable. In the case of the "Dreadnought," the official figures show that her turbines could easily develop 20 to 25 per cent more power than that obtained in the nominal full-power trial, and still have the inlet pressure not higher than it would be in the steam-chest of a reciprocating engine working with the same boiler-pressure. In the navy, since the introduction of water-tube boilers it has been usual to generate steam at, say, 250 pounds pressure, and reduce this to 200 pounds at the engines, a reserve thus being provided, which greatly facilitates station-keeping. In the "Dreadnought," however, the reduction was nearer 100 pounds than 50 pounds, and, as Mr. Griffith stated at the conference, the torque on the shafting is nearly proportional to the inlet pressure of the turbines. That the practice of "over-turbining" is not confined to the navy would seem to be borne out by the statement, recently published, that at the late overhaul of the "Carmania" an attempt was made to reduce the steam-way through the turbine by twisting the blades to a more acute angle. This expedient might work fairly well in the case of an electric-light turbine, which is usually not greatly under-speeded, but seems somewhat questionable when applied to the conditions of marine practice, as it must materially increase the losses by shock.

We are unaware as to the considerations which have led in so many cases to the provision of turbines so far in excess of the actual requirements of the ships to which they have been fitted. Partially, perhaps, the practice has originated in the methods used for proportioning the turbines, which are understood to be largely of "the rule-of-thumb character." This belief finds confirmation in Mr. Gerald Stoney's statement at the Engineering Conference—that an efficiency ratio of 78 per cent was attained in the recent test at Carville Power Station, particulars of which were published in Engineering, May 17 last, page 654 *ante*. From the data given it is obvious that the figure stated has been obtained in a purely empirical fashion, the actual efficiency rated being certainly under 70 per cent.

Perhaps one of the most important pronouncements made in the recent conference was that in which Sir W. H. White expressed his belief in the ultimate discovery of an efficient form of high-speed screw-propeller. His unrivaled experience gives him a right to express an authoritative opinion on this matter, and we sincerely trust that he is not unduly sanguine. The day which witnesses the development of a propeller capable of efficiently developing a large thrust at a really high speed of revolution renders obsolete the ordinary marine engine. In the case stated it would not survive even in the modified arrangement now proposed for slow-speed vessels, in which an exhaust-steam turbine is to take the place of the low-pressure cylinder. As matters stand, this proposal yields promise of a very substantial fuel economy, but we fear it will, in spite of its merits in this regard, be deemed by many as a somewhat inartistic makeshift.

For larger and faster vessels superheated steam may ultimately come into general use. The fact that for a given pressure the volume of the steam is very substantially increased has some advantages from the theoretical standpoint, since longer blades would be in order at the high-pressure end, thus reducing the ratio of the clearance to the height of the blades. It is generally understood, however, that in practice this has not hitherto proved possible, and that, on the contrary, the use of highly superheated steam has necessitated an increase of clearance, so as to avoid the risk of the blades fouling the casing through unequal expansion. If the superheat could be maintained with sufficient steadiness, this necessity would not arise; but as matters stand, many "strips" have arisen solely from a too sudden change in the temperature of the supply of superheated steam. On land such "strips" are annoying, but involve little danger; but at sea conditions are different, and Mr. Parsons's reluctance to sanction the use of superheated steam there is accordingly very easily intelligible.—Engineering.

Carboazotine Blasting Mixture.—*a*. Heat the mixture, nitrate of potash (soda or lime), 50 to 64 parts, sulphur 13 to 16 parts, spent tanbark 14 to 16 parts, soot, lampblack, etc., 9 to 18 parts, sulphate of iron (green vitriol) 4 to 5 parts, with a corresponding quantity of water, to 230 to 248 deg. F., allow it to cool, dry the solid matter, and shape it into tiles, etc. *b*. Mixture of 1 part wood charcoal, 16 parts nitrate of barium, and 1 pint of nitrocellulose, with some water, to a paste, shape it into disks, and dry it. *c*. Nitrate of potash, soda, or lime 50 to 60 parts, sulphur 13 to 16 parts, tan or sawdust 14 to 16 parts, soot 9 to 18 parts, and water.

THE SOURCES OF HONEY.

THE PHYSIOLOGICAL FUNCTIONS OF THE NECTARY.

BY GASTON BONNIER.

Honey is not found ready formed in flowers. The saccharine liquid which the bee extracts from the flower is collected in a pouch of the digestive tube where it is mixed with diastase. It is disgorged in the hive, where the greater part of the water is evaporated, while the sugar is transformed by the chemical action of the diastase. When this transformation is complete and the quantity of water is reduced to 25 per cent, the honey is stored in cells which are hermetically closed with wax.

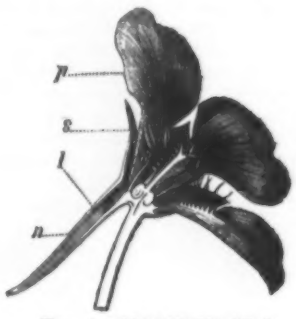


Fig. 1.—MONKSHOOD.*

The sweet liquid which is secreted by many flowers has received the poetic name of nectar. It exudes from the surface of organs called nectaries and consists chiefly of cane sugar (saccharose), fruit sugar (dextrose and levulose), and water.

The physiological function of the nectaries and their utility to the plant have been discussed since the 17th century and various theories have been suggested. The recently published researches of the Dutch botanist Burck (*Revue générale de Botanique*, 1907) have revealed a hitherto unsuspected function of the nectary, but before giving the results of these and other researches, it is necessary to describe the positions and forms of nectaries, which vary greatly in different plants.

Fig. 2.—PETAL OF HELLEBORE, TRANSFORMED INTO A NECTARY.

There is some accumulation of sugar in the tissues at the base of every flower, and this sugar, as I proved in 1879, constitutes a reserve store of material which is utilized by the plant, after flowering, in the first stage of development of the fruit and the seed. But the invariable presence of nectaries does not imply an invariable production of nectar, for the saccharine liquid does not exude except under favorable conditions. Oats, wheat, and barley, for example, which are never visited by honey-making insects, have a great deal of sugar at the base of their flowers.

Furthermore, plants of the same species may yield much nectar in one country and none in another, as I have demonstrated by comparative studies in Norway, the Alps, and the vicinity of Paris. Many species produce nectar at high altitudes and in the north of Europe, but yield none when growing in southern plains.

Fig. 3.—MIGNONETTE FLOWER, WITH PETALS REMOVED.

A general idea of the composition of nectar may be obtained from the subjoined analysis:

Nectar of the honeysuckle.	Per cent.
Water	76
Saccharose (cane sugar)	12
Glucose (fruit sugar)	9
Dextrine, gum, mineral matter and loss	3

* In all the figures, unless otherwise specified, *p* indicates a petal, *s* sepal, *n* nectary, *l* nectar, *g* exuded drop of nectar, *e* or *et* stamen, *c* carpel, *ov* ovary, *cal* calyx, *cor* corolla, *f* duct. Heavy shading indicates accumulation of sugar.

Now the honey which the bees make from this honeysuckle nectar contains only 25 per cent of water. Hence a great quantity of water—more than twice the weight of the resultant honey—is evaporated by the bees. The evaporation is effected by spreading the freshly-gathered nectar over a large surface of comb and exposing it to a current of air, furnished by the wings of a number of bees which are assigned to act as "ventilators." De Lageus has proved that the number of these ventilators found at work in the evening is proportional to the amount of nectar collected during the day.

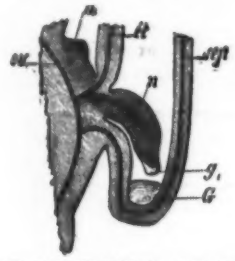


Fig. 4.—PART OF FLOWER OF CRUCIFERÆ.

Furthermore, most of the cane sugar in the nectar is converted, in the honey, by the action of diastase, as is shown by the following analyses of the sugars of nectar and honey, into "invert sugar," which consists of equal parts of dextrine and levulose:

	Sainfoin nectar.	Sainfoin honey.
Cane sugar	57.2	8.2
Dextrine and levulose	42.8	91.8
	100.0	100.0

The proportion of cane sugar left in the honey varies with the source of the nectar. It is greatest in white mountain honey and is sometimes zero in honey from Brittany and the Landes. In recent years honey has been adulterated with the aid of the bees by feeding them on glucose syrup, perfumed with artificial flower scents. The adulteration is readily detected by the polariscope because commercial glucose consists entirely of dextrose, which turns the plane of polarization strongly to the right. The deviation produced by natural honey is much smaller because the dextrose formed from the cane sugar by the action of diastase is mixed with levulose, which turns the plane of polarization to the left.

Fig. 5.—BUCKWHEAT.

The nectaries of plants vary greatly in form and position. The nectary of the monkshood is a tubular spur of one of the sepals. When the tube is nearly full, honey bees can reach the nectar from the interior of the flower, but if there is only a little nectar they can obtain it only through holes that are often made by the strong jaws of humble bees. In the hellebores the petals are transformed into nectaries. The nectary of the mignonette is an orange colored ring surrounding the bases of the stamens. The nectar exudes from the surface and is easily accessible. In the cabbage and other *Cruciferæ* the nectar exudes and drops from little excrescences around the bases of the stamens and collects in the cup-shaped bases of the sepals beneath. The bee thrusts her proboscis between the stamens and petals from the interior of the flower if there is little nectar, between two sepals, from the outside, if there is much, and between a petal and a sepal, from one side, if the cup is overflowing. The nectaries of buckwheat resemble those of *Cruciferæ*. That of the heath is a ring surrounded by the stamens and the nectar accumulates in the bottom of the tubular corolla. Those of the periwinkle, sage, and horehound are large fleshy masses in contact with the pistil. In the house-leek (*Sempervivum*) the bases of the numerous rose-colored petals constitute the nectaries.

Fig. 6.—HEATH.

In most flowers the surface of the nectary bears many *stomata*, or little mouths formed by the apposition of two large cells and communicating with ducts. Sometimes nothing but water vapor escapes from these orifices, but when the plant is traversed by an abundant upward flow of water, some of this water takes up sugar in the tissues of the nectary and issues from the stomata : fine drops of nectar. Under these conditions the flow of nectar is constant. If the exuded nectar is removed by blotting paper, fresh drops appear immediately at the stomata.

Fig. 7.—OVARY AND NECTARIES OF PERIWINKLE (TRANSVERSE SECTION.)

The quantity of nectar produced by a given plant varies according to climate, weather, atmospheric humidity, composition and moisture of soil, and the hour of the day. I have obtained nectar from plants which do not naturally yield a drop in our climate by placing the pots containing them in water and surrounding them with a moist atmosphere. This experiment has succeeded with Oriental hyacinths, tulips, rue, goose-grass (*Galium*) and lily of the valley.

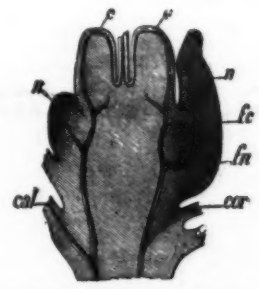


Fig. 8.—OVARY AND NECTARIES OF SAGE. (LONGITUDINAL SECTION.)

Some plants have nectaries situated outside of the flower, usually at the beses of leaves. These nectaries are very large and rich in sugar, especially cane sugar, in the infancy of the leaf, but as the accumulation of sugar is used in promoting the growth of the leaf, the nectary of a full-grown leaf is generally very small and almost destitute of sugar.

One of the most singular of extra-floral nectaries is found as a stipule on a cultivated variety of vetch. It yields a very rich nectar, which is gathered by bees even before the flowers open. The edges of cherry, prune, hawthorn, and some other leaves often bear little prominences which in favoring conditions exude a nectar which is sought by bees. Active nectaries may even occur on cotyledons, or seed leaves, as in the castor-oil plant. The Italian botanist Delpino regarded extra-floral nectaries as bait for wasps which, in turn, he supposed to drive away ants and caterpillars. In reality these nectaries are simply material reserved for the development of the leaf.

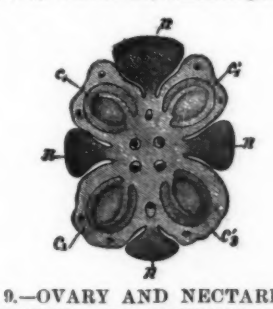


Fig. 9.—OVARY AND NECTARIES OF HOREHOUND. (TRANSVERSE SECTION.)

But nectar is not the only source of honey. On

sunny days in summer and late spring objects placed under linden and some other trees soon become covered with drops of a sweet viscous liquid, known as honey dew. It exudes, not from special nectaries, but from the general surface of young and even of full-grown leaves. Honey dew may be produced annually on very hot days, and it is exceedingly abundant in very dry seasons, when it forms a valuable supply for the bees, although it yields an inferior honey owing to the presence of gum and dextrine. The trees and shrubs which most frequently produce honey dew in

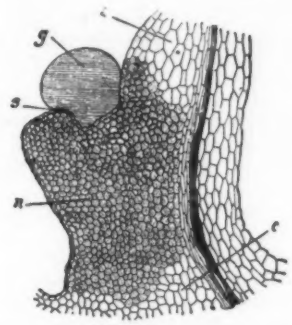


FIG. 10.—STRUCTURE OF NECTARY OF HOUSE-LEEK. (MAGNIFIED.)

France are the oak, ash, linden, maple, poplar, birch, hazel, mountain-ash, blackberry and barberry. It is occasionally found also on certain herbaceous plants, including salsify, scorzonera, and some *Cruciferæ*. Usually the honey dew is excreted or rejected by plant lice (aphides), which extract the sweet sap of leaves but digest only a small proportion of it. This variety is known in France as *miellat*. But honey dew is sometimes exuded directly from the stomata of leaves in the absence of plant lice. This variety is true honey-dew, or *miellée*.

I have experimentally demonstrated the possibility of the production of honey dew without the agency of

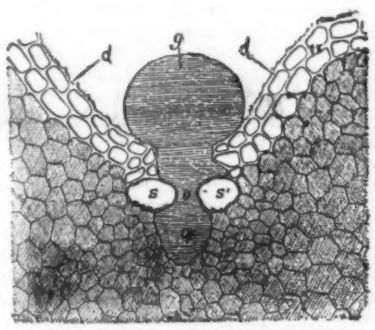


FIG. 11.—PART OF NECTARY OF PEACH BLOSSOM MAGNIFIED. SHOWING THE TWIN CELLS *S S'* OF A STOMA *O*. THE CELLS *d* ARE DESTITUTE OF SUGAR.

insects by placing a cut branch in a moist atmosphere and immersing its end in water. In a short time many fine drops of sweet liquid appeared on the under surface of the leaves.

Bees do not gather either variety of honey dew when nectar is abundant.

In regard to the utility of nectaries to the plant, Darwin adopted the view, first expressed by Sprengel in the eighteenth century, that their function was to attract insects and that the flowers of each species were so nicely adapted to the conformation of insects of a particular species that the latter, in their search for nectar, would necessarily convey pollen from one flower to another and thus effect cross-fertilization.

I have shown elsewhere the exaggeration of this theory of mutual adaptation of flowers and insects,

FIG. 12.—STIPULE AND EXTRA-FLORAL NECTARY OF VETCH.

and Richer has recently proved by ingenious experiments that the complexity of form of flowers has no relation to their habit of self-fertilization or cross-fertilization. We have seen that not all nectaries are situated in flowers and that many flowers have nectaries which produce no nectar.

But every nectary, whether it is floral or extra floral, and whether it exudes nectar or not, contains a reserve store of sugar which is ultimately used to promote the rapid development of a neighboring organ. The floral nectaries accumulate cane sugar which, after pollination, is converted into other substances by invertine or other diastases and utilized in the development of the fruit and seeds.

Another function of floral nectaries has recently been discovered by Burck. They enable the anthers to open and discharge their pollen even in wet weather. The anther cannot open until it has become very dry and its desiccation is commonly attributed to the dryness of the air. Burck found that, in most species, the desiccation of the anthers is little affected and their opening little retarded by covering the plant with a bell glass and keeping the air inside saturated with moisture, the water in the stamens and anthers being attracted and absorbed by the sugar in the adjacent nectaries. If the flow of water is prevented by tying a thread tightly around a stamen the anther remains closed long after the other anthers of the same flower have opened. Burck expresses a hope that he will soon be able to announce a third function of the nectary. At all events it is now certain that this organ is useful to the plant directly and not only indirectly by attracting insects.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from La Science au XXme Siècle.

A REMARKABLE ARITHMETICIAN.

By Dr. ALFRED GRADENWITZ.

THE astonishing achievements of Dr. Gottfried Rückle have created a sensation in Berlin. Rückle is an arithmetician so thoroughly trained that he is able to surpass any professional calculator.

FIG. 13.—NECTARY ON COTYLEDON OF CASTOR OIL PLANT.

An instructive account of his methods is given by Dr. Rückle in a recent article in the Berlin Tageblatt. He shows that his feats in arithmetic, while extraordinary, can be accounted for by the laws of nature. Professional arithmeticians in their own interests are intent on hiding their achievements in clouds of mystery. Dr. Rückle prefers offering a simple explanation of his art.

The fact that the capacities of memory are of a rather different kind in different individuals is well known. Dr. Rückle possesses a special capacity for figures, which by practice he has succeeded in developing to an extraordinary degree of perfection.

Attention was first drawn to arithmetical memory at the beginning of the last century, when the famous mathematician Cauchy was astonished at the arithmetical achievements of a simple shepherd named Mondeux. Systematic investigation of extraordinary memories was then made in the nineties, when Prof. Binet at Paris published a treatise on two French professional arithmeticians, Inaudi and Diamandi.

FIG. 14.—APHIS EXTRACTING SAP FROM LEAF.

Attention was first attracted to Dr. Rückle's memory and arithmetical capacities about 1901, when his extraordinary speed in mental arithmetic attracted the attention of the psychologist G. E. Müller, who made a number of experiments on Dr. Rückle, and delivered a short account of these experiments before the first Congress of Experimental Psychology held at Giessen in 1904. While the professor was delivering his address, Dr. Rückle had to learn by heart a number of 102 figures. This he succeeded in achieving within about four minutes, and he was able to render before the Congress simultaneously with this number the very words in which Prof. Müller's account had been delivered during the time the arithmetician was learning the cipher.

A remarkable fact is that the capacity of *visual* and *auditive* perception is alike developed in Dr. Rückle; that is to say, he is able to retain both the figures he sees and those he hears. However, the most important base of his achievements is the power of visual perception, acoustical perception being only a transitory phase to the optical fixing of the material. Whenever he hears a number spoken, he immediately visualizes it and so to say photographs it on his brain.

The difference between visual and auditive perception will be understood from these instances: Inaudi, whose capacities were merely acoustical, required 6 to 8 minutes to learn by heart a number of 50 figures, whereas 42 to 45 seconds are sufficient for Dr. Rückle. Inaudi requires 15 minutes and Diamandi 25 minutes in the case of a number of 100 figures, while Dr. Rückle's average achievement is 3 minutes and 40 seconds. In the case of a number of 204 figures, Inaudi's art failed completely, while Diamandi required 1 hour and 35 minutes. Dr. Rückle will learn such a number in 12 minutes and 23 seconds.

The methods of this arithmetician are different from ordinary arithmetical processes, mathematical principles being used, even in solving problems of a simple nature, and memory being assisted by detaching from more extensive series, certain groups of figures. In learning for instance a number of 100 figures, which begins thus: 36835429684531 . . ., Dr. Rückle will detach sets of six figures as individual groups, which he fixes as such in his memory. In the case of the cipher 368,354, as in the above instance, he will easily retain that the second half is somewhat smaller than the first; in the second group of six figures, 296845, he readily recognizes that the second half is about three times that of the first. He thus establishes some points of rest, which will be instrumental in guiding him through the apparent crowd of figures. After seizing each individual group of six figures, he again looks for associations between these, and then will be able readily to retain the whole number. These associations are easily found by considerations such as that one group contains a number of even, and another a number of odd figures, that one is far greater and the other far smaller and by similar effects of contrast. These combinations take place in his brain very quickly, which accounts for his surprising rapidity in memorizing.

The manner in which multiplication problems are solved by him is illustrated by the following instance, which will no doubt be understood by anyone acquainted with the principles of mathematics. Supposing the numbers 10,027 and 9,973 are to be multiplied together. Instead of starting immediately, Dr. Rückle takes advantage of the fact that the first cipher is 10,000 + 27 and the second 10,000 — 27. He then applies the well-known mathematical formula:

$$(a + b)\ (a - b) = a^2 - b^2,$$

that is to say in the present case:

$$(10{,}000 + 27)\ (10{,}000 - 27) = 10{,}000^2 - 27^2.$$

Thus he has only to solve the far easier problem given on the right side of the equation, thus saving much work in calculating. Such application of mathematical formulæ, which Dr. Rückle calls his mathematical system of economy, can be made in practically any case, although opportunities are not always as favorable as in the present instance.

In many cases Dr. Rückle will be uncertain as to what mathematical system is most adapted to the problem at issue. This is especially noticeable in mental arithmetic. In fact in many cases he has been asked: "Why is it that you should have taken two seconds longer to solve this problem, which is so much simpler than the previous problem?" The answer is that Dr. Rückle has been hesitating between different methods of calculating, or that certain figures of especially striking properties have induced him to try some new methods.

In solving multiplication problems, Dr. Rückle readily avoids any gross mistakes by an arithmetical checking process, which is made even automatically. In squaring 4367, he knows immediately that the answer is between 18,000,000 and 19,000,000, and that the terminal cipher will be 89, 67^2 being = 4,489.

As regards the learning of numbers comprising an even higher number of figures, Dr. Rückle thinks to be able within 1½ to 1¾ hours to learn a cipher of 500 figures without any excessive fatigue, while a number of 1,000 figures, provided the problem were worth the extraordinary waste of time, would take about 6 to 7 hours. In fact there is a certain law controlling the time of learning long numbers, the times increasing approximately at the same rate as the squares of the number of figures.

Many observers have been surprised at the absence of any appreciable mental fatigue as a consequence of these experiments, which is a striking contrast to the case of ordinary professional arithmeticians; in fact, 3 to 4 hours of mathematical arithmetic are to Dr. Rückle a pleasure rather than a strain on his brain. To ascertain combinations, to find out associations between apparently inanimate matters, is to Dr. Rückle a most attractive occupation, which will never result in fatigue. Numbers, in his own words, are his passion, figures are his best friends.

THE SEED, A CHAPTER IN EVOLUTION.*

A RESUMÉ OF RECENT KNOWLEDGE.

BY PROF. F. W. OLIVER, M.A., D.SC., F.R.S.

THE seed-character is the distinctive mark of three great groups of plants—the Pteridosperms, Gymnosperms (including Cordaiteæ), and Angiosperms. Nor will it be seriously questioned that the possession of this organ has given supremacy to seed-bearing plants over groups not thus characterized in a majority of the types of environment where vegetation is able to exist. Exceptions, of course, there are, though few of them are wholly immune from the invasion of the Spermophyte. The sort of habitat, for instance, in which *Zostera* flourishes—sometimes to the exclusion of other forms—is held more as a result of vegetative aggressiveness than in virtue of any special power conferred by the seed-habit.

Our knowledge of those plants which had attained to the seed-bearing condition in a bygone age has undergone some extension during the last few years; the seed, too, has shed its glamor over other branches of morphological inquiry, so that no serious apology is necessary for its selection as the subject of this morning's discourse.

It is generally conceded that the primitive vegetation arose in the waters, and that with the parting of the waters and the emerging of land and continents this primitive stock of plants was sufficiently plastic to take advantage of the new conditions, throwing up successive hordes which effected a footing on the land, and in time peopled the whole earth with forms adapted to the varying habitats and climates as they differentiated.

Of the character of these primeval aquatic types no direct information has been vouchsafed. It is a matter of inference that they possessed much in common with the green Algæ of to-day, which, living in a biologically stable medium, are commonly regarded as their nearest representatives. Be that as it may, the complexity of the life-history of existing Algæ and the frequent presence of neutral generations seem significant of the capacity of their progenitors to originate forms with sporophytes adapted to terrestrial conditions.

In our liverworts and mosses on the one hand and the ferns and their allies on the other, two divergent evolutionary lines are represented, both fitted to existence upon land surfaces, but handicapped by the retention of a non-terrestrial method of effecting the sexual process. In the Bryophytes the physiological continuity and dependence of the sporophyte upon the gametophyte is preserved throughout, and it never rises above the status of an elaborate spore-capsule; while the gametophyte, though often reaching a complex vegetative differentiation, offering many analogies with the sporophytes of higher plants, is condemned to pigmy dimensions through the incubus of the inherited aquatic mechanism of fertilization.

Though remote from the series that have culminated in seed-plants, the Bryophytes are a group offering many an instructive parallel with the main series of plants; certainly these forms have remained too long a thing apart. Haberlandt and Goebel have shown us—to name no others—how happy is the hunting-ground which the Bryophytes provide. Further work is still required, directed more especially to certain important points in the life-history.

With the regular vascular cryptogams the relations between the stages are of course different. Here we find large complex sporophytes holding the ground, but hampered by the ever-recurring necessity of dependence upon outside water for the performance of the reproductive process.

The land problem was solved on ingenious lines. The differentiation of gametophytes which accompanied heterospory rendered possible the retention of the larger spore and female prothallus. Thus retained aloft, the drawback of the double existence is overcome and the advantages of the elaborated sporophyte more fully realized. The water conditions are brought directly under the plant's control through the device of the pollen-chamber, and the way paved for the ideal seed with siphonogamy.

All the elements of the seed were present before, but combined compactly in this new way we recognize what is virtually a fresh stage intercalated in the life-history. Further elaboration came bit by bit as the possibilities were successively realized. With the evolution of the seed, the plant rose at a bound to a higher plane, and this structure in its perfected form has become the very center of the plant's existence.

The case of *Cycas* and *Ginkgo* with motile sperms affords an extreme demonstration of the inertia of heredity, the persistence in living seed-plants of the original aquatic flagellate type.

Obsolete as they are and faced with extinction, these survivors from the middle epoch of the world's history still hold their ground in a few scattered localities. In this connection we shall listen with interest to Prof. Pearson's account of the *Encephalartos*-scrub of South Africa which is to occupy us during the course of the present sitting of the Section.

How the sperms became replaced ultimately by the passive cells of the pollen-tube we have no knowledge.

If the conjecture be well founded that the change came late rather than early, then the conservatism of the spermophytic line in this respect stands in marked contrast to the adaptability that is so characteristic of another phylum of aerial plants. The ready evolution of siphonogamy in the form of fertilizing tubes, so common in the Fungi, perhaps finds its explanation in the close filiation of this group with primitive and plastic forms. The fertilizing tube may reasonably be regarded as a special case of a general susceptibility to chemiotactic stimuli which distinguished the whole hyphal complex of the group from very early times. In the case of the spermophyte, on the other hand, the motile spermatozoid seems to have persisted through a long and complicated ancestral history, so that its elimination may have been less easy of achievement.

The seed, once evolved, became the center of a host of accessory organs, constituting what we know collectively as the fruit and flower. By these it has been robbed, as we shall see, of many of its pristine functions, and at the same time has undergone marked structural reduction. In the highly elaborated Angiosperm more especially we find an almost stereotyped uniformity in seed-structure contrasting with an infinite diversity in the outward floral husk.

In attempting a sketch of the origin of the seed one has to admit at the outset that recent discoveries bring us no nearer to its prototype than we were a decade ago. For the seeds of the Pteridosperms are advanced structures recalling quite vividly the type long familiar in living Cycads. It would be overstating the case to say they have nothing primitive about them, but there is a long chapter in evolution to be deciphered before we can connect, say, the seed of *Lyginodendron* with the sporangium of any fern at present known to us.

The great interest of the recent correlation of seeds with Coal Measure plants lies less in the structure of these correlated seeds than in the very extensive series of plant remains which we have thus come to recognize as belonging to the earlier Spermophytes.

For the position of these plants had remained in suspense. The elaborate anatomical investigation which their vegetative organs had received at the hands of Williamson, Scott, Solms-Laubach, and others showed them to occupy a transitional position between the Ferns and Cycads. In certain respects they showed an advance in the cycadian direction, while in others they were wholly fern-like. Their fructifications were unknown, and their nature remained an open question. It was for this group, or series of transitional groups, that Potonié proposed the appropriate name of Cycadofilices.

We know now that the Lyginodendreæ and Medulloseæ bore seeds attached to their fronds. The seeds have been found attached in some cases to reduced fronds consisting of a branching rachis, in others to fronds of the normal filicinean type. Indeed, so far as habit is concerned, these plants may rightly be described as seed-bearing ferns.

As such, indeed, most people will be content to regard them—as forms, that is, having close filicinean relationship in which the reproductive method has been profoundly modified, the internal anatomy to a less extent, and the habit hardly at all. Had these Pteridosperms come to light during the lifetime of Hofmeister that master of morphology must have pounced upon them as furnishing an important link in his chain. These fossils and the spermatozoa which the Japanese botanists discovered in the seeds of *Cycas* and *Ginkgo*, indeed, afford the most convincing direct evidence of the soundness of the Hofmeisterian scheme that it is possible to conceive. Nor is that all. For by confirming the indications first revealed by the earlier investigation of the vegetative anatomy, the Pteridosperms have afforded us a striking object lesson of the value of the anatomical method—of the significance of purely anatomical characters too long ignored by the systematist.

Not so long ago, when new examples of these Pteridosperms were turning up on every hand, some pessimists were inclined to wonder whether, after all, any groups of real ferns existed in the Palæozoic rocks. Such sporangia as were known might well be the pollen sacs of seed-bearing plants. All doubts on this score are happily set at rest by the detection of germinating fern-spores in contemporary beds. Nor can I think of any more fitting tailpiece to the investigations which lead the way to the Pteridosperms than the discovery, by the same investigator, of the antidote to these rather disturbing views. However, it is needless to dwell further on these matters now, in view of Dr. Scott's address to-morrow upon the "Present State of Palæozoic Botany."

But to return to the history of the seed. In the absence of direct evidence, one can only conjecture that some old generalized type of sporangium formed its prototype, something substantial, on the lines of a *Botryopteris* or *Zygopteris*, perhaps. The heterospory that was the precursor of the seed-like condition must have been a transient phase, or else it is lost in the pre-Carboniferous obscurity. Be that as it may, the passage from the dehiscent to the indehiscent monosporal megasporangium finds its analogy in every group of plants. Where there is extreme numerical reduction of the contained structures—be they spores or seeds—a multitude of cases in the Fungi, in the Algæ, and the angiospermic flowering plants show that dehiscence tends to become obsolete. The failure to dehisce does not appear to be directly correlated with any mechanical difficulty in ejaculation. It is more probably one of those obscure cases of interdependence of phenomena in which the vegetable kingdom abounds. A special investigation directed to the elucidation of this point might be expected to yield interesting results.

We now come to the consideration of a most characteristic organ of the seed—the pollen chamber. This cavity arises at the apex of the megasporangium, above the big megaspore, and is found in all the Palæozoic seeds, with the sole exception, so far as I am aware, of the "seed-like" structures in *Lepidocarpon* and *Miadesmia*. The utility of the pollen chamber is manifest, but its antecedents are quite unknown. Upon such a structure as this may have depended the success of the seed method at a critical stage in its evolution. In the viviparous Selaginellas, described some years ago in America, the archegonium on the prothallus of the retained megaspore is fertilized by sperms liberated from microspores which become caught in the lips of the open megasporangial wall. This analogy suggests to us that the pollen chamber cavity may be a relic or modification of the original place of dehiscence. If this conjecture be true, we have here what was once an exit pore converted to the purposes of ingress, just as we find, in so many Thallophytes, tubes and beaks, once, as it is supposed, the orifices of zoospore discharge now serving for the reception of male gametes.

A great feature in the early seed types was the complexity of the integument, and this still holds good in recent Cycads and some other Gymnosperms. Protective envelopes are so commonly associated with reproductive organs, and the nutritive conditions are so favorable to their production, that a naked nucellus strikes one as anomalous. If future research confirm the supposition that the ferns which stand in possible relation to early seed plants were ex-indusiate, like the Marattiaceæ, recent and fossil, then no doubt the seed coat is a new formation, having no true homology with, but merely homoplastic resemblance to, ordinary fern indusia. The only case of a naked nucellus that recalls itself is the rather mysterious instance of *Lepidocarpon* in which Dr. Scott reports the not infrequent occurrence of non-integumented megasporangia with the prothallus fully developed.

The robust nature of the seed envelope, which was often drupaceous, is in complete harmony with the whole character of the seed if you regard the habit at its inception as a xerophilous adaptation. And such no doubt it was, an improved method whereby the plant became independent of chance water at a very critical stage in the life history. Some of the peculiarities of fossil seed coats, especially the ribbing of the Lagenostomas and several other genera, may be attributed to a multiple origin of this structure, at any rate in some cases. The remarkable circlet of tentacles which surrounds the summit of *Lagenostoma physoides* (best known by Williamson's earlier name *Physostoma elegans*) suggests that a number of foliar lobes have been incorporated in the seed, while the presence of perimicropylar ridges and the septate canopy in allied forms may be taken as only a less evident indication of the same thing.

The relation between the integument and sporangial body of recent Gymnosperm seeds is found to be an inconstant character, and the same is true of the fossils. In general character the relationship recalls that which obtains between the ovary and receptacle of an Angiosperm. The Lagenostomas resemble *Cycas* and

* Read before the Botanical Section of the British Association for the Advancement of Science.

Pinus in having the integument free at the apex only, while *Taxus*, *Phyllocladus*, and *Araucaria* are in agreement with the Trigonocarpons and other seeds, which are generally attributed to Medulloseæ, in having an integument which rises freely from the chalaza. It is interesting to note that the fossil seeds of the latter group show an additional complexity in the wall of the nucellus. For in them a series of tracheal strands or even a mantle of tracheides is found running up from the chalaza to the pollen chamber. It is evident that nothing was spared in these older seeds to insure adequate access of water to the pollen chamber where the sperms must have been liberated.

In due time the protective sheath, or testa, appropriated other functions supplementary to that of protection. Of these the most important must have been the reception of the pollen. A very striking feature in all the Lagenostomas is the way in which the tip of the nucellus (where the orifice of the pollen chamber is situated) projects beyond the integument. In these seeds the microspores must have had direct access to the pollen chamber without first descending a micropylar canal.

In the Medullosean seeds also the nucellus is distinguished by a long beak, as Dr. Scott and Mr. Maslen have shown recently for *Trigonocarpon*, and, as we know, in *Stephanospermum*, and many other cases. So far as we know, this beak does not extend to the surface, though it engages with the micropylar canal, and is continued some distance up.

Though it can hardly be supposed that the long beak has been inherited from the ancestral sporangium, its presence may be none the less significant of what took place when the seed method was initiated. The direct pollination in *Lagenostoma* may well be a survival from the old days when no proper micropyle existed. But when the micropyle closed in, the conservative nucellus would for a while endeavor to maintain direct communication with the exterior. The beak-like appendage on this view would be a new formation evolved *pari passu* with the integument.

(To be continued.)

ST. SWITHIN'S DAY.

ORIGIN OF THE LEGEND.

BY J. H. MORRISON

THE legend as we have received it says that St. Swithin was born about the year 800, became a monk, and gradually rose to the head of his religious community. He died in 862, leaving directions that he should be buried "where the feet of passers-by might tread, and the rain of heaven fall on his tomb." He was buried on the north side of the church at Winchester, England, where the rain dropping from the eaves of the building washed on the tomb. Many years later his body was to have been raised and buried inside the walls of the church on July 15, but according to the tradition, in consequence of excessive rains which continued for forty days, the removal of the body was delayed. Out of this circumstance arose the current belief at that day, that if rain falls on July 15, it will continue to fall every day, more or less, for forty days following. The belief is still strongly current.

It is thought that in the legend as now current we have the survival of some pagan day of custom or superstition, which has been handed down to us through the life or labors of some ecclesiastical saint.

This prediction of forty days' rain does not seem to be received in the main with much credit, though it must be said there are many believers in the legend even in this country. This superstition was brought *here during the* colonial days, and in some parts of the country can be found as a current saying even at this day, having been handed down from one generation to another, and no doubt from this legend sprung other superstitions of the weather molded to meet the altered conditions of the climate in the new country.

One of the very early historians says of this day: "The fearful deluge of rain on the day of St. Swithin, as it was general throughout the kingdom, and led to a dreadful famine, may for anything at present known to the contrary have given to that saint his watery name. It is exceedingly probable that we have here the real origin of the popular belief on this subject. There is nothing in the life of St. Swithin to connect him with rainy weather, but there seems to be enough in the above inundation and its widely extended consequences to make a general and lasting impression on the nation."

The belief in the peculiar characteristics of St. Swithin's day, and the references to the miracles, are thus noted in Poor Robin's Almanac for 1697:

"In this month is St. Swithin's day,
On which if that it rain, they say,
Full forty days after it will,
Or more or less, some rain distill.
This Swithin was a saint I trow,
And Winchester's Bishop also;
Who in his time did many a feat,
As popish legends do repeat.
A woman having broke her eggs
By stumbling at another's legs,
For which she made a woeful cry,
St. Swithin chanced for to come by,
Who made them all as sound or more
Than ever that they were before.
But whether this were so or no,
'Tis more than you or I do know.
Better it is to rise betime
And to make hay while sun doth shine
Than to believe in tales and lies
Which idle monks and friars devise."

Apples seem to have been under the influence of St. Swithin, for either their good or bad condition, as we find it said:

"Till St. Swithin's day be past
The apples be not fit to taste."

"It is a bad job for the apples that St. Swithin hath not rained on them. Because, unless St. Swithin rains upon them, they will never keep through the winter."

Great Britain is not the only nation that had a St. Swithin. There was an Italian St. Swithin in St. Bibiana; then there was a French St. Swithin in St. Medard; a German, a Welsh St. Swithin, and a Scotch St. Swithin. If these St. Swithins opened the floodgates at the same time, it is no wonder there was a famine in the several lands. While there appears to be want of unanimity among the early writers as to the dates of the activity of these saints, still there is no doubt of there being a common purpose on their part to bring on a deluge of rain at a set period for forty days. It would seem as though Great Britain had the original St. Swithin, while the others were merely imitators.

There has been little, if any, literature upon the character of the weather for the forty days following St. Swithin's day produced in the United States. There does not appear in any of the writings by the meteorologists in this country in the early days of the nineteenth century any reference to this day; probably on account of being a foreign superstition. Great Britain, no doubt, has covered this subject more fully than any other country, as it was evidently the home of the superstition, and should have the credit. Honor where honor is due.

This superstition was one of the many beliefs without evidence of that early date that has been handed down to us, and that has gradually melted away when placed under the X rays of the scientific record. During the eighteenth century, when the researches of science the world over began to take some definite form, this superstition was looked upon with much doubt as to its accuracy, but it was not until the record of rainfall at the Greenwich Observatory was analyzed for this period, that the St. Swithin day legend received its first blow from an authoritative source; and that is comparatively but a few years ago, as the following records show.

GREAT BRITAIN.

From observations made at Greenwich Observatory for twenty years, from 1841 to 1860, both years inclusive, the number of rainy days each year, when July 15 was *wet*, and when it was *dry*, is given in the following table:

July 15 Wet.		July 15 Dry.	
1841....	23 days.	1842....	12 days.
1845....	26 "	1843....	22 "
1851....	13 "	1844....	20 "
1853....	18 "	1846....	21 "
1854....	16 "	1847....	17 "
1856....	14 "	1848....	31 "
		1849....	20 "
		1850....	17 "
		1852....	19 "
		1855....	18 "
		1857....	14 "
		1858....	14 "
		1859....	13 "
		1860....	29 "

Notes on "The St. Swithin's Day Tradition" by Prof. W. W. Bryant, as further tested for a long period at Greenwich, appeared in The Observatory Magazine for November, 1904. This it will be seen covers the period given in the above table, as well as for more than forty years later.

"A letter from a Dumfries correspondent in the October number of Symon's Meteorological Magazine has suggested an inquiry as to the verdict of the Greenwich records on this subject. I have examined the figures for sixty-four years, 1841 to 1904, counting only the days when 0.005 inch was registered, and it certainly seems that the tradition does not find very strong support.

"In some few years, 1856 to 1863, when the rain gages were only examined at 9 P. M., there is a little doubt as to the day on which rain actually fell, but it is of no great consequence.

"In no year were there more than thirty-one nor less than four wet days in the forty succeeding July 15, so that the probability of absolute accuracy of the tradition vanishes at once.

"In twenty of the years at least half of the forty days were wet, but in only five of these years was St. Swithin's day wet, and it was dry in the two years showing most wet days in the forty. On the other hand, although in the two driest seasons, with only four and six wet days respectively, in the period under consideration, St. Swithin's day was wet, yet in 1887, after a wet July 15, only nine of the forty days were wet.

"From another point of view the heaviest rainfall during the forty days, which was 9.73 inches in 1903, followed a dry St. Swithin's day; and of the sixteen years in which that period produced over four inches of rainfall, only two had a wet St. Swithin's.

"It would seem therefore that the legend does not apply to Dumfries or Greenwich. Perhaps Winchester records might tell a different tale, but it is not likely, even if they allowed for the change of style, which would alter the date by a week.

"It is noticeable that there has been no rain at Greenwich on July 15 since 1896; and in the whole period there are forty-one dry festivals as against twenty-three wet ones.

"On an average, a wet St. Swithin's entails seventeen wet days out of the next forty, with an average total rainfall of 3.13 inches; and a dry one brings the same number of wet days with an average total rainfall of 3.33 inches."

The Dumfries paper above referred to gives a table covering eighteen years, from 1887 to 1904 inclusive, showing the condition of the weather so far as regards the rainfall on July 15, and for the forty succeeding days, and sums up with an analysis as follows: "From the above table it will be seen that from 1887 to 1904 there was no year in which rain fell for forty days after the 15th. The greatest number was thirty-four in 1895, and in that year no rain fell on the 15th. There were three years in which rain fell on twenty-eight days, and in all these the 15th was wet, and the total amount ranged from 6.52 inches to 7.79 inches. On the other hand, the next heaviest rainfall to these was 5.54 inches in 1893, with twenty-six days in which it fell, and in that year the 15th was dry; and in 1897, in which the 15th was also dry, there were twenty-four days, with 4.85 inches of rain, the next largest amount to those above specified."

According to a report made by the French consul at Helsingfors concerning the importation of electrical products in Finland, it appears that the imports are on the increase for the last ten years, and the increase has been two-thirds since 1896 from an absolute standpoint, and about one-half from a relative standpoint. It seems that the imports are to keep on increasing in the future, as is shown by the first reports published for 1906, in which the weights only are known. These figure for the electrical products at 756,638 kilogrammes (1,668,084 lbs.) in place of 667,827 (1,472,291 lbs.) in 1905. For this year and the next the market seems to show the most favorable conditions. As a certain number of towns in Finland are now operating municipal electric plants, it seems likely that others will follow their example. Three of them in fact, Nystad, Lovisa, and Nyslott, have decided to build electric plants this year. Besides, the question has come up as regards using electric traction upon a part of the state railroads. A commission which was appointed to make the preparatory reports has already chosen a certain number of streams and is making agreements with the proprietors of the adjoining ground. Therefore the matter seems to be progressing rapidly. Seeing that the manufacturing industries which have been developing within the last eighteen months are on the increase, there will no doubt be new factories erected in which electric lighting and motors will be used.

ENGINEERING NOTES.

On June 17 Gov. Hughes, of New York, approved the bill of Senator Page amending the penal code so as to make it a misdemeanor for any railroad to permit "any employee engaged in or connected with the movement of any train to remain on duty more than sixteen consecutive hours, or to require or permit any such employee who has been on duty sixteen consecutive hours to go on duty without having had at least ten hours off duty, or to require or permit any such employee who has been on duty sixteen hours in the aggregate in any twenty-four-hour period to continue on duty or to go on duty without having had at least eight hours off duty, within such twenty-four-hour period; except when, by casualty occurring after such employee has started on his trip, or by unknown casualty occurring before he started on his trip, and except when, by accident, or unexpected delay of train scheduled to make connection with the train on which such employee is serving, he is prevented from reaching his terminal."

Street pavements between and for two feet on either side of the outside rails of street railway tracks are laid and maintained at the expense of the railway companies in the State of New York, in accordance with Section 98, Chapter 39, of the general laws enacted in 1890. Much difficulty is experienced in compelling the companies to conform to this act, and the authorities of Rochester were recently compelled to take such a case of refusal to the United States Supreme Court. The Rochester Railroad Company was incorporated under the laws of 1884, containing a similar provision to that mentioned, to take over the property of the Rochester City & Brighton Railroad. The latter was incorporated under the general laws of 1850, and in 1869 was relieved by a special act from keeping any part of a permanently improved street in repair. Since 1898 the new company has refused to pay any part of the cost of repairing along the lines of the old company, on the ground that it is the successor to all the privileges of the old company, among them exemption from such charges. The Supreme Court has ruled, however, 27 Sup. Rep., 469, that a new company incorporated under the laws of 1884, cannot claim the benefit of any contract exemption from a contract exemption enjoyed by a predecessor in title.—Engineering Record.

Security holders of the Guayaquil & Quito Railroad have appealed to the British Foreign Office and to the American State Department to make representations to Ecuador not to institute forfeiture proceedings against that road. Recent dispatches from South America that the republic would take over the property of the road on the ground that it has not been completed on time, alarmed the security holders. The State Department has instructed the American minister to Ecuador upon the matter, and according to reports the British Foreign Office has taken the stand that the rights of the holders of the road's certificates must be fully protected. Besides a stock issue of more than $12,000,000, the railroad has issued approximately $12,282,000 of 6 per cent bonds, with the proceeds of which the road has been constructed almost all of the 350 miles from Guayaquil to Quito. Of these bonds, about $2,000,000, it is said, are held in the United States. The rest are held in England and France. The contract provided that the road should be finished within ten years after June 14, 1897, but it was also provided that the company should have three days' extension for each day that the work was delayed by revolutions, epidemics, or other unavoidable causes. The bondholders contend that the road has had to face all these troubles and that it is, therefore, entitled to at least a year more within which to finish it.

A line of railroad which presents some points of interest has been built in the German possessions of southwest Africa by the Arthur Koppel firm. It is used for carrying copper ore from the Otair mines to the port of Swakopmund, and is a narrow-gage line of 262 miles' length. Recently it has been opened for traffic for the use of the colony. Some difficulty was found in the construction of the line, owing to the invasion of the Hereros in 1903, and other troubles. There are 110 bridges, which are all of metal work, with piers and abutments of masonry. The largest is the bridge over the Khan River near Usakor, which has five 60-foot spans. As to the track construction, it is of steel rails laid upon steel ties, using 30-pound rails. The ties are four feet long and weigh 26 pounds each, using thirteen ties for a rail length of 28 feet. Thus constructed, the track is much heavier than the government railroad from Swakopmund to Windhuk, which has the same gage, 24 inches. Two types of locomotive, somewhat the same in appearance, are used, the first being furnished by the Henschel firm and the others by the Jung company. These locomotives have three driving axles and will draw an 80-ton train at 25 miles an hour. A heavier locomotive is coming into use which will take a 100-ton train. In all, there are thirty-six locomotives on the line. Freight and passenger cars are used. There is now a considerable passenger traffic, and at last accounts 10,000 tons of freight were carried per month. The cost of building the road is about $50,000 per mile.

ELECTRICAL NOTES.

The Berlin Metropolitan Subway has a part of its line supplied with current from a converting station known as the Bismarckstrasse substation. It is of considerable interest from several standpoints, and its object is to convert three-phase current received from another plant into direct current. The three-phase circuit works upon 10,000 volts, and the capacity of the substation is about 2,800 kilowatts. It produces direct current for the operation of the car motors, which are run upon 750 volts. The present station is installed underground, and is laid out for five groups of dynamos with transformers for each group. At present there are two sets of machines in service. The transformers are contained in oil boxes, and the latter are cooled by water upon the outer surface. Current from the high-tension line passes in the primary of the transformer and the secondary is connected to the rotary converter in each case. These latter dynamos run at 480 revolutions per minute and have six collector rings to receive the alternating current. From the other side is taken 750-volt direct current from the commutator. A storage battery gives the current which is needed to start up the machine.

Comparing the two different kinds of trolleys which are used for electric cars, either for tramways or electric railroads, we find that the wire loop or arch trolley, pressing against the wire from the car roof, is used generally throughout Germany, while on the contrary, in England and America the trolley of the usual roller type is preferred. But according to the results which are obtained in practice it is found that the arch trolley has the following advantages: first, small wear of the trolley wire; second, freedom from breakage of the current between trolley and wire; third, a more simple arrangement of stretching wires in the overhead construction in curves and switching points. However, on the other side of the question, we find that it has several disadvantages. For instance, the value of the current cannot exceed a certain value for each contact. According to W. Michel, this is 50 amperes for the normal and 150 amperes at starting. This can be avoided by using several trolley wires in parallel. Again, the arch is found to wear rapidly, but this can be diminished by lubricating or by the use of non-friction metal. It is also noticed that the pressure of the trolley upon the wire is not sufficient at high speeds. For this reason, in standard-gage railroads where heavy locomotives or motor cars are used, the pantagraph trolley is preferred.

A project of considerable interest is being discussed in France, according to which the Rhone River is to be utilized for securing a large amount of current, and this will be transmitted by a power line to Paris, so as to add greatly to the current which is now on hand from the existing central stations. Should this be carried out, it would be one of the most extensive examples of power transmission in Europe. The distance is about 250 miles. The question is now being taken up for consideration by the Electrical Engineers' Society of Paris. Messrs. Blondel, Harlé and Mahl have already gone into the practical side of the matter, and as a result of their investigations it appears that there will be no unusual difficulties in the way of executing such a project. M. Harlé, an eminent electrical engineer of the city, recently presented a report upon the subject which shows that it is quite feasible in the present state of the art. The hydraulic work would consist of a dam which is erected across the gorges of the Rhone, so as to form an immense reservoir, the dam to have 220 feet height. It will be located near Genissat, which is the most favorable point. An offtake canal leads to a number of basins, each having a separate penstock leading to the turbine house. The latter is placed below the dam along the river bank. A head of water of about 200 feet can be obtained. In the turbine house there will be placed at the beginning a number of dynamo sets representing a total of 200,000 horse-power. Each of the units of the station will consist of a 9,000 horse-power turbine connected direct to a three-phase alternator or a direct-current generator, according to the system which is chosen. One of the penstocks will supply a pair of such turbines, the penstocks being five feet in diameter. Either the direct-current method of distribution, or the Thury constant-current system, or the three-phase system can be used. In the latter case the power line will be run by two lines of three wires each, mounted upon trelliswork poles. Such a line could be operated at a tension of 120,000 volts without great difficulty and perhaps even at 150,000 volts. At Paris, the line would be received in a large substation, which serves as the starting point for the distribution in the city. The idea is to use the current mainly for large consumers, and it would cost much less than at present, as the prices are too high to allow of extensive use of electric motors in the different industries.

TRADE NOTES AND FORMULÆ.

To Harden Steel Piano Strings.—The steel wire must be heated to redness and cooled off; then immersed in a freshly melted metal bath of 40 parts lead, 12 parts zinc, 26 parts antimony, 21 parts tin and 1 part bismuth. When taken out, sprinkle or pour cold water over it.

Varnish for Cartonnage Work.—1. Six parts of gum sandarac, 4 parts of powdered mastic mixed with 4 parts of glass powder dissolved in 30 parts of strong alcohol, add 2 parts of Venice turpentine and dissolve by heating. 2. Six parts of gum sandarac dissolved in 24 parts of strong alcohol, add 4 parts of previously melted gum elemi.

Cedar Wood Imitation.—Small articles of whitewood can be given the appearance of cedar, by means of a stain composed of 200 parts of catechu (Japanese earth) 100 parts of caustic soda and 1,000 parts of water. In this stain, the articles must be boiled for several hours, then rinsed off, and dried, and if they are not dark enough, boiled over again. This stain penetrates so deeply into the wood that the colored articles can be worked over again.

Caramel color serves for the coloring of liquors and sugar goods yellow to brown. In making caramel, cane sugar is melted over a fire in an enameled vessel, and while continuously stirred, is heated until it drops from a spatula dipped into it, in a ruby-red stream. Then it is poured onto a cold metal plate. After it is set, it is broken into pieces and kept in a well-closed glass vessel. Properly prepared caramel is tasteless (not bitter) and readily dissolves in water and alcohol.

Imitation Boule Furniture.—The furniture surfaces, executed originally in various wood shadings, at the places at which metal-plated effects are aimed at, are painted *a la sgraffito* with a mixture of graphite and gum arabic, graphite and wood varnish, or also graphite and water glass, and afterward exposed to a galvanoplastic (electrotyping) bath, whereby, on the places treated with graphite, the desired metals—copper, silver—are deposited. These deposits are then smoothed with a burnishing tool and afterward covered or protected with an appropriate varnish (copal).

Adhesive from Carragheen (according to J. Bescle).—Sixty parts of carragheen moss is soaked in 1,200 parts of water, then boiled. To the carragheen decoction, 6 parts of carbonate of potash are added and the fluid concentrated by evaporation, until a sample drop on glass remains attached, suspended, on cooling. Hereupon the fluid is filtered through a cloth or sieve and to the filtrate 5,000 parts of warmed water glass, of 38 deg. to 40 deg. B. added, constantly stirring. To the mixture thus obtained 2,500 parts of rock candy, moistened with water is added. As soon as the candy has dissolved, the mixture, if necessary, is still further concentrated, until it is ropy, whereupon the thus far finished adhesive is removed from the fire and thoroughly mixed with 75 parts of glycerine.

Carmine, soluble (for histological purposes).—1. Dissolve 20 parts of crystallized sodium carbonate in 100 parts of distilled water, add 5 parts of pulverized carmine, mix it thoroughly and stand the fluid in a saucer, covered, on the fire. When boiling commences, add 30 parts of absolute alcohol and allow it to cool. The solution is hereupon filtered and to it gradually added 300 parts of water acidulated with 8 parts of a 20 per cent aqueous solution of acetic acid; in the whole finally 2 parts of chloral hydrate is dissolved. 2. Crystallized picric acid is moistened with so much ammonia as to produce a soft paste, and stirred up with a glass rod. The whole is evaporated in a water bath until the ammonia odor is no longer perceptible. With this amorphous ammoniacal picrate a cold saturated filtered solution is prepared, equal parts of this and the mixture above described mixed together, and the mixture evaporated in a porcelain dish. The absolutely dry residue is rubbed down to a fine powder and kept in closed vessels. For use a 1.5 per cent solution of it is taken.

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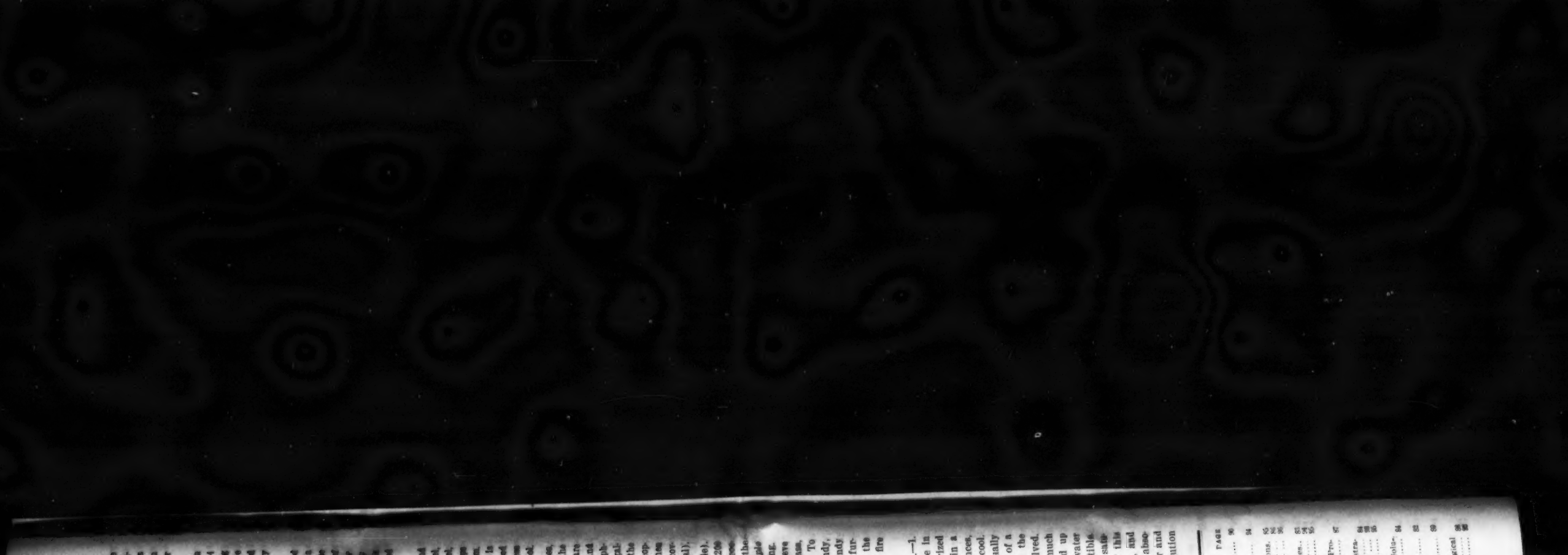
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